

Towards the Common Good:

An Expansive Post-Abyssal (Re)stor(y)ing of the Epistemic Cultures of the Citizen Sciences

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By

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Abstract

The citizen sciences convene complex and reflexive ecologies of knowledges in response to a range of social-ecological risks. Their epistemic cultures seem to be assembled in ways which increase potential mobilisation of the common knowledges being produced, thereby producing knowledges in forms that are more strongly aligned with a range of implementation strategies. However, much of such processes of knowledge production have been 'cleaned out' of official accounts through scientifically hegemonic systems of legitimation, deepening hegemonically-entrenched systems of epistemic, contributory and distributive injustices, and undermining the potential for stronger enactments of participatory and radical democracies. The engagement of sociologies of absences and emergences in this study evidence these epistemic insights, thereby evidencing an expansive post-abyssal (re)stor(y)ing of the citizen sciences.

Through this research, I consider knowledge production as 'commoning', towards the constitution of the common good. To date, most accounts of knowledge production within citizen science projects primarily focus on scientific processes of knowledge production and legitimation. Such accounts neglect the ecologies of diverse knowledges through which knowledge is being collaboratively produced, the forms of learning that occur, or the ways in which such ecologies are mobilised in response to specific social-ecological risks. To better understand the ways in which citizen science projects build risk-responsive common knowledge, I bring a focus to the diversity of epistemic cultures convened, speaking to this gap. My primary research question is: How do the epistemic cultures within citizen science projects enable commoning in response to social-ecological risk?

To begin, I establish a particular vantage point from which the remainder of the thesis is launched, one which centres as the primary interest of knowledge production, an interest in social-ecological justice and the constitution of the common good. From this vantage point, knowledge co-production and learning can be viewed as acts of commoning, which themselves constitute common goods. I draw on the work of Karin Knorr Cetina to conceptualise and frame notions of epistemic cultures and their epistemic features. Expanding notions of epistemic cultures from a post-abyssal perspective, I draw on the work of Bruno Latour and Boaventura de Sousa Santos. Latour's distinctions between the production of 'matters of fact' and 'matters of concern' provide a way to challenge hegemonic systems of scientific knowledge production, while preserving the potential emergence of multiplicity in the context of evolving risk, thereby enabling a greater degree of situated reflexivity. Santos argues for the reclamation of all ways of knowing, including but not limited to scientific ways of knowing the world. He argues that other forms of knowledge are produced as nonexistent, and that they might be reclaimed through engaging sociologies of absences and emergences. Both authors enable a stronger analysis of knowledge

production in terms of its ability to intervene into context in response to manifest risks. These three theoretical approaches are convened into an analytical framework for the study.

To enact sociologies of absences and emergences, I engage two forms of immanent critique, complemented by an epistemic mapping of 50 South African citizen science projects, and an analysis of three illustrative case studies. The first critique is one of produced nonexistence, through which I consider three aspects of the general knowledge cultures within which the epistemic cultures of citizen science projects are situated. This critique makes evident the ways in which the ontological and related conceptual structures of hegemonic scientific knowledge production actively produce as nonexistent, other onto-epistemic contributions to knowledge production in response to social-ecological risks. The second critique reviews the field of peer-reviewed literature through a reading of presence and absence, with a focus on the articulation of epistemic cultures. Predictably, a key finding is that this form of scientific reporting primarily foregrounds legitimated scientifically processed knowledge, while once again producing as nonexistent, other forms of knowledges. However, there is evidence of increasing accounts of citizen science which recognise both a diversity of knowledge contributions, and epistemic, contributory and distributive justice issues as regards hegemonic forms of reporting.

The epistemic mapping evidences a highly diversified field of citizen sciences, whose epistemic cultures are convened to produce distinct forms of scientifically-informed knowledges in response to diverse contexts, scales and notions of risk. The three illustrative case studies engage sociologies of absences and emergences, with particular focus on articulating the ecologies of knowledges evidenced in project documentation, including both official and unofficial accounts of epistemic activity. This analysis highlights the significant contributions of diverse forms of knowledges, including scientific, situated, embodied, governance, indigenous, spiritual and relational knowledges, and the ways in which these knowledge are convened to respond to specific configurations of risk. It once again highlights issues of epistemic, contributory and distributive justice, and makes evident the need for stronger integrity in processes of producing and reporting common knowledges. The case studies also illustrate the increased effectiveness of leveraging an ecology of knowledges (in contrast to a monoculture of scientific knowledge) in response to situated risks, including how such ecologies have a tendency to be generative and enable multiple forms of intervention into structures and applied contexts of intervention. In response to the collective research findings, a think-piece on rigour-as-integrity is offered as a contribution to commoning, in response to social-ecological risk. The piece draws together a post-abysal system of rigour intended to strengthen knowledge production in ways which actively centre forms of justice and commoning.

Śhiva Saṅkalpa Sūkta

(A hymn to truth and clear insight)

AUM yad jāgrato dūram udaiti daivam
tadu suptasya tathaivaiti
dūraṅgamam jyotiṣām jyotir ekam
tan me manaḥ śiva-saṅkalpam astu

yena karmāṇi apaso manīṣiṇo
yagye kṛṇvanti vidatheṣu dhīrāḥ
yad apūrvam yakṣam antaḥ prajānām
tan me manaḥ śiva-saṅkalpam astu

yat pragyānam uta ceto dhṛtiśca
yat jyotir antaḥ amṛtam prajāsu
yasmān na ṛte kiñcana karma kriyate
tan me manaḥ śiva-saṅkalpam astu

yenedam bhūtam bhuvanam bhaviṣyat
parigrhītam amṛtena sarvam
yena yagyas tāyate saptahotā
tan me manaḥ śiva-saṅkalpam astu

yasmin ṛcaḥ sāmaḥ yajūrṁṣi yasmin
pratiṣṭhitā rathanābhāvivārāḥ
yasminś cittam sarvam otam prajānām
tan me manaḥ śiva-saṅkalpam astu

suṣārathir aśvān iva yan manuśyān
nenīyate'bhīśubhir vājina iva
hṛtapratiṣṭham yad ajiram javiṣṭham
tan me manaḥ śiva-saṅkalpam astu

In the service of collective consciousness.
Honouring and reaching towards the consciousness that is shared among all life.
Towards the common good.

- From the 34th Chapter of the Yajur Veda -

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Acronyms

ACSA - Australian Citizen Science Association

ADU - Animal Demographic Unit

BCE - Before the Common Era

BIRP - Birds in Reserves

BMPs - Biodiversity Management Plans

BOP - Birds with Odd Plumages

BotSoc - Botanical Society of South Africa

BSP - Biodiversity Stewardship Programmes

CAR - Bird Roadcounts

CDA - Critical Discourse Analysis

CLO - Cornell Laboratory of Ornithology

CR - Critically Endangered (Conservation status)

CRC - Citizen Report Card

CREW - Conservation of Rare and Endangered
Wildflowers

CREW CFR - CREW Cape Floristic Region (Node
designation)

CREW FOTH - CREW Friends of Tigerberg Hills

CSA - Citizen Science Association

CSAsia - CitizenScienceAsia

CSOs - Civil Society Organisations

CSTP - Citizen Science Theory and Practice
(Journal)

CWAC - Coordinated WaterBird Counts

DEA - Department of Environmental Affairs

DIY - Do It Yourself

DS - Development Studies

ECPTA - Eastern Cape Parks and Tourism
Agency

ECSA - European Citizen Science Association

EIA - Environmental Impact Assessment

ELRC - Environmental Learning Research Centre

EN - Endangered (Conservation status)

ESE - Environmental and Sustainability
Education

ESKOM - Electricity Supply Commission

EWI - Endangered Wildlife Trust
FBIP - Foundational Biodiversity Information
Programme

GEO6 - Global Environment Outlook 6

GPS - Global Positioning System

GIS - Geographic Information System

ifah - ifoundahedgehog

IUCN - International Union for Conservation of
Nature

IWR - Institute for Water Research

IWRM - Integrated Water Resources
Management

JISC CETIS - Joint Information Systems
Committee - Centre for Educational Technology
& Interoperability Standards

KSG - Khulumani Support Group	SARCA - Southern African Reptile Conservation Assessment
LGBT - Lesbian, Gay, Bisexual and Transgender	SAFRING - South African Bird Ringing Unit
miniSASS - Mini Stream Assessment Scoring System	SANParks - South African National Parks
MLM - Makana Local Municipality	SDGs - Sustainable Development Goals
MobiSAM - Mobile Social Accountability and Monitoring platform	SOCC - Species of Conservation Concern
MSB - Millennium Seed bank	STS - Science and Technology Studies
NBA - National Biodiversity Assessment	TACO - Treating the Text as a Critical Object
NEAG - Noordhoek Environmental Action Group	TEK - Traditional Ecological Knowledge
NEMA - National Environmental Management Act	TPNP - Towards Practicing a New Paradigm project
NEMBA - National Environmental Management of Biodiversity Act	ToadNUTS - Noordhoek Unpaid Toad Savers
NERCS - Nest Records	UNESCO - United Nations Educational, Scientific and Cultural Organization
NGO - Non Government Organisation	UNEP - United Nations Environmental Programme
NPCS - National Plant Conservation Strategy	US - United States of America
NT - Near Threatened	ViTH - Virtual Tree Herbarium
NWSCOOOP - National Weather Service Cooperative Observer Programme	VU - Vulnerable (Conservation status)
ORI-CFTP - Oceanographic Research Institutes Cooperative Fish Tagging Project	WfD - Water for Dignity
PHOWN - Photos of Weaver Nests	WfD CoP - Water for Dignity Community of Practice
SABAP - Southern African Bird Atlas Project	WLT-CC - Western Leopard Toad Conservation Committee
SABAP2 - Southern African Bird Atlas Project 2	WSF - World Social Forum
SABCA - South African Butterfly Conservation Assessment	WULA - Water Use License Application
SANBI - South African National Biodiversity Institute	

PRELUDE

Orienting to the Thesis

0.1. An Initial Reflection

I begin this process by briefly outlining the starting point of this study because the initial intention of the study shifted significantly after the first process of data collection and analysis. The remainder of the thesis report outlines that emergent process, and so it is important to lay its foundation here.

When I started this study, my primary interest was in understanding how learning happened within an 'innovative' networked pedagogy - that of citizen science. The process began with an extensive literature review, followed by an initial small pilot consisting of a soft review of three South African citizen science project portals, and a basic level of Critical Discourse Analysis on the "About Us" text on these sites. The mini-pilot was used to inform the development of research questions within the theoretical framing of Cetina's 'epistemic cultures' (2007). The pilot was also used to inform and guide the development of my initial data collection tool - what I refer to as an 'epistemic mapping' tool. I will outline the details of both this theoretical framework and the findings from the epistemic mapping in the chapters that follow. What is significant to note at this point is that the findings, both in terms of the numbers and diversity of projects, and in terms of the epistemic features of the citizen science projects reviewed, called for me to revisit my research questions. They required revisiting not because the initial questions were flawed, but because they seemed to be place holders for a set of more significant questions around the relationship between knowledge co-production, learning and action in response to social-ecological risk.

Where the study began with an interest in facilitating knowledge production and (hopefully) epistemic access into the sciences, it became about knowledge production as a praxis in the real world, beyond the sciences. While the study began with an interest in social justice, what came out of that first level of analysis was a need to more carefully and faithfully consider epistemic justices as they were enacted in hegemonic systems of knowledge production, and in response to wicked social-ecological risks. The complexity encountered within the first level of analysis required engagement beyond the sciences and into an exploration of what counts as legitimate knowledge in the context of interconnected global and local risks, and how we could co-produce knowledge that legitimately meets both the need to know and also the need to act in context.

This called for a review of the theoretical framework I had initially developed for the study because while the initial framework enabled me to account for the findings in this initial data set within the space of mainstream scientific research, it did not fully nor authentically account for the rich epistemic practices I encountered within citizen science projects.

0.2. A Multi-Modal, Multi-Process Thesis:

This thesis attempts to present in a coherent and understandable way, what I can best describe as a circular (in that it often looped back upon itself, calling on me to rethink and revisit my earlier understandings and framings) and iterative research study. Because theses are currently linear in nature (reporting start to end in a logical sequence), I have struggled to authentically represent how this particular study developed. While it is an acceptable research practice to 'clean up and order' research reports such as theses, the argument that has emerged through this research process calls for a more careful representation of the 'messiness', and more authentic reporting of the non-linear development of knowledge insights arising through this study.

In an attempt at more authentic representation, I endeavoured to provide a multi-model orientation to key areas of the thesis. These take the form of:

- a) Multi-process diagrams which illustrate processes and relationships in the thesis in ways other than the linear representation of words on pages, and which attempt to maintain the visibility of messiness within the study;
- b) Textual play, where fonts and text alignments are used to intentionally signal movements and shifts beyond what is contained within the text itself; and
- c) Summarising diagrams at the end of each of the first four chapters, which serve as holding spaces for key movements in thinking towards the articulation robust and rigorous post-abyssal expansions of epistemologies.

As will become evident in the remainder of the thesis, these three processes form part of my attempt to represent the process of knowledge-building within this study in more authentic ways, and in alignment with the theoretical framework into which the study grew. Because I will be using them from the beginning of the thesis report, I thought it prudent to alert readers to them here at the start.

0.3. Orientation to the Thesis

In this section, I provide an orientation to the thesis. I begin by presenting my research questions, which I explicate more deeply in Chapter 4. I then outline each chapter in the thesis, including their connections to each other. *Figure 1* at the end of the outline, provides a visual overview of my thesis design, summarising the relationships between various elements within the thesis.

Research Question:

How do the epistemic cultures within citizen science projects enable commoning in response to social-ecological risk?

Sub-Question 1:

What is the epistemic landscape of citizen science within South Africa?

Sub-Question 2:

How are ecologies of knowledges constituted within particular citizen science projects?

Sub-sub question: In which ways do diverse knowledges and types of knowing contribute to knowledge co-production, learning and action within the citizen sciences?

Sub-Question 3:

How are the epistemic cultures of citizen projects articulated within peer-reviewed scientific reporting?

Philosophical Question: (philosophical re-orientation)

How are broader knowledge cultures, within which specific epistemic cultures are located, constituted to privilege or denigrate, legitimate or delegitimate particular types of knowers and knowledges, and towards which ends?

Sub-sub question: How might this enable or disrupt commoning in response to social-ecological risk?

In **Chapter 1**, I aim to establish a specific vantage point from which to launch the remainder of the thesis - one which centres as the primary interest of knowledge production and learning, an interest in *the common good in response to social-ecological risk* - it is at its root, a post-abyssal vantage point. This conceptual framing forms an important foundation towards researching the epistemic cultures of citizen science projects specifically because it problematises more institutionally naturalised foundations associated with conceptions of 'environment', and current cultures of knowledge production and learning. It is a preliminary move towards a larger argument for re-thinking what counts as valid knowledge, and who count as valid knowledge producers in relation to social-ecological risk. I also provide an overview to the field of citizen science to orient the reader to my field of focus. Chapter 5 provides a more substantive critical review of the field of citizen science practice as represented in peer-reviewed literature.

Chapter 2 is dedicated to articulating the theoretical and conceptual framework of epistemic cultures - especially as it is conceptualised within the context of this study. In it, I outline and specifically conceptualise the various aspects of epistemic cultures which have been investigated in the context of citizen science practice, drawing on the vantage point developed in Chapter 1. This work draws heavily on the knowledge-as-practice work of Carina Knorr Cetina. The notion of epistemic cultures is developed through two post-abyssal critiques of knowledge production, first drawing on the political ecology work of Bruno Latour, and second, on the 'Epistemologies of the South' work of Boaventura de Sousa Santos. Between them, they more substantively develop the post-abyssal vantage point opened in Chapter 1. This chapter also provides the foundation from which the critiques in Chapter 3 emerge.

Chapter 3 is written in the form of three converging lines of critique of the general knowledge cultures within which the specific epistemic cultures of citizen science projects are located. Between them, these three critiques bring to the fore, a range of modes of produced non-existence within hegemonic systems of knowledge production in response to social-ecological risk.

- *Critique 1*: Knowledge production within modernist western sciences: A critique of ontological dissonance;
- *Critique 2*: Science and its publics: A critique of knowledge flow; and
- *Critique 3*: The construction of environmental risk within the Anthropocene: A critique of knowledge production in response to risk.

I draw these three lines of critique together by arguing for the establishment of robust onto-epistemic imaginaries which adopt relational and historically situated articulations of risk, and which take account of the relationships between people and the rest of the web-of-life. This argument establishes a critical perspective from which to engage with specific epistemic cultures within the arena of citizen science. Foregrounded in the chapter are implications for knowledge production, learning and risk-responsive action. This chapter also provides the basis from which to consider more complex understandings of the epistemic cultures of citizen science projects, and potentially reframes what should or could count as knowledge production and learning towards the common good. It forms the first of three critical systematic knowledge reviews contained in the thesis. It is in effect, a ground-cleaning chapter.

Chapter 4 contains an outline of the iterative (re)search methodology adopted in the study. This chapter draws on arguments made in previous chapters to frame and then reframe a more authentic, post-abyssal approach to researching the epistemic cultures of citizen science projects. Special emphasis is placed on methodological-theoretical coherence, ontological politics, and an ethical approach foregrounding an interest in the common good.

In **Chapter 5**, I engage in a critical systematic review of the literature emerging from the field of citizen science - the second critical systematic knowledge review in the thesis. I particularly review literature foregrounding an interest in citizen science as a methodology for knowledge production and learning. Drawing on a review of 60 peer-reviewed publications, this chapter aims to provide robust insight into how epistemic cultures are being articulated in the field more broadly, in addition to identifying what is considered to be legitimate knowledge within such reports. The review includes two processes for reading the field of literature a) a review of how epistemic cultures are articulated and represented; and b) engagement with the logics of production evident through what is and is not articulated within literature (Santos, 2007, 2004). Through this second process, I re-read the literature for absence in order to articulate areas of contestation, absence and incongruence within the literature. This chapter engages with the critiques outlined in Chapter 3, challenging and problematising the ways in which knowledge production and learning activities are being reported primarily on the basis of a particular hegemonic mode of scientific legitimation, and highlighting the challenge with such an approach.

Chapter 6 presents a critical mapping review of the South African field of citizen science practice, drawing on data collected from 50 citizen science projects. Particular focus is placed on articulating a range of epistemic features within different forms of citizen science activity, drawing primarily on the work of Cetina (2007) and Latour (2004). Chapter 6 contains the third and final critical systematic review in the thesis.

In **Chapter 7**, I re-search the epistemic cultures of three citizen science projects, this time drawing on Santos's 'sociologies of absences and emergences', and especially on Santos's articulation of 'ecologies of knowledges'. The 'sociology of absences' is made more explicit through three illustrative case studies from the field of South African practice. The analysis in this chapter provides evidence to support a call for the development of a wider perspective on what counts as legitimate knowledge and who count as legitimate knowers, opened up in the early chapters of this thesis. Chapters 6 and 7 together begin to articulate the potential and evident practices within citizen science approaches as relational toolkits for 'commoning' towards a range of common goods.

In **Chapter 8**, the final chapter of this thesis, I offer a range of knowledge propositions emerging from the three forms of critical systematic review engaged in this study (theory, literature and practice). I foreground the role of onto-epistemic imaginaries, and sociologies of absences and emergences as ways of generating and informing such imaginaries, within the epistemic cultures of the citizen sciences. Finally, I conclude with the insights emerging from this study and their implications for engaging citizen science as commoning systems in response to social-ecological risk, towards the promotion of the common good.

TOWARDS THE COMMON GOOD: AN GENERATIVE POST-ABYSSAL (RE)STOR(Y)ING OF CITIZEN SCIENCE THESIS OVERVIEW

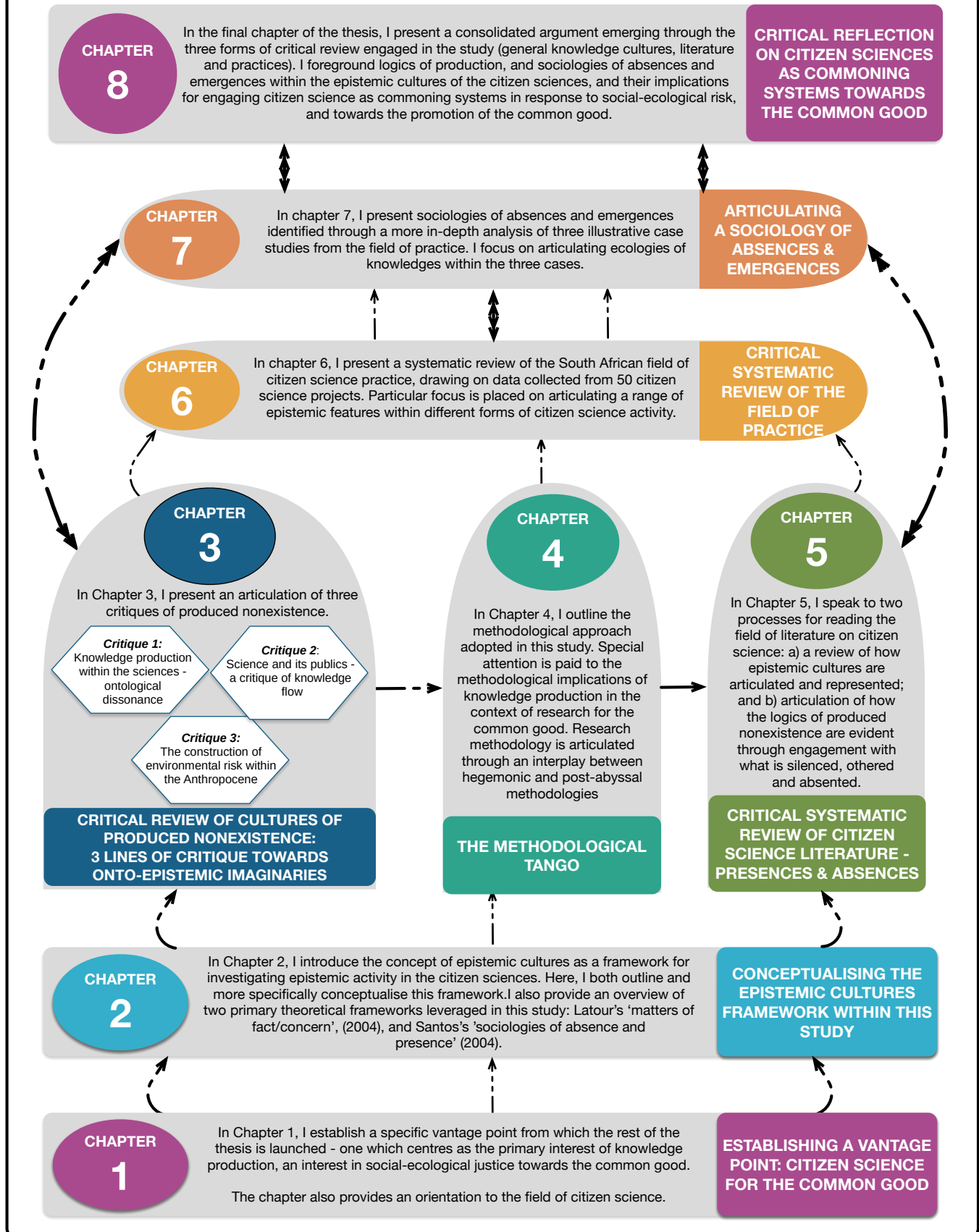


Figure 1: Overview of the Thesis

CHAPTER 1

Establishing a Vantage Point: Citizen Science for the Common Good

Opening(s)

I am interested in The Common Good, and all the common goods that are enfolded in that soft, *fluid* ideal. I am interested in the good(s) we *hold* in common, and also in the *holding of* good(s) in common. I am interested in (re)stor(y)ing in ways that provide more fertile openings and vantage points for goodness in common(s), and for the imagining, thinking, and enacting in common, in good ways. This includes:

(re)stor(y)ing, and
(re)imag(in)ing, and
(re)membering, and
(re)challenging, and
(re)thinking, and
(re)presencing, and
(re)knowing and (un)knowing, and also
(re)placing, and
(re)enacting and (re)acting,
... together
... or accompanied (when togetherness is less good),
... or respectfully (when accompaniment is less good),
... or in ways that reclaim good freedoms (when 'respect' undermines
what is good)

It includes holding what is meant by 'good' and 'common' in fluid, always-emergent tensions,
- for *specific* times in *particular* places,

... and maybe, possibly, sometimes, for *all* places and all beings, at *particular* times.

At this specific time, in this particular thesis, my interest is enacted through engagement with the ways of (re)acting and (re)knowing performed within citizen science projects. My interest is about the practice of citizen science in South Africa in particular, and also about citizen science in many places (*all* is too big a word in this instance). I would like to understand how and why knowledge is being produced and used in response to social-ecological risk within citizen science projects, and how this might be considered commoning, and contribute to the common good.

My research question, which I more fully establish in the first half of the thesis, is:

***How do the epistemic cultures within citizen science projects enable
commoning in response to social-ecological risk?***

More than the specific focus on citizen science, this study is also about The Common Good(s) that citizen science practices provide openings for - those ways of contextually-emergent collective learning and action that might provide bridges to new forms of knowledge production in response to social-ecological risks at broader scales. My intention is for the work here to provide good openings towards common wellbeing by attending to the ways we do (and might) know, as we navigate an increasing range of wicked problems in the world, and to argue for the power of working with onto-epistemic imaginaries as we do so.

What I don't intend is to provide clear-cut answers, certain, straightforward solutions, or definite direction as replacements for those ways of knowing which I critique and trouble; my intention throughout the thesis is to engage in the work of expansive post-abyssal¹ (re)stor(y)ing and (re)presencing as contributions to The Common Good(s). This is a slow thesis - one in which as much time is spent on carefully and rigorously (re)stor(y)ing conceptions of how and why we produce knowledge, as is dedicated to evidencing the cultures of knowledge production within citizen science projects in South Africa and elsewhere. It does so through its focus on theory critique, literature critique and practice critique.

1.1. Opening the Chapter

I specifically consider citizen science as an arena of activity which is experiencing rapid uptake globally, and which provides emergent systems of knowledge co-production that are being leveraged in response to social-ecological risks in multiple ways. Understanding the cultures of knowledge and learning — or epistemic cultures² — produced by a range of citizen science projects provides insight into the various ways in which people across a range of contexts are co-producing knowledge, and learning and responding to situated and global risks together. I draw on the emergent relationships between knowledge production and learning, and critically reflexive engagement with situated social-ecological risks to illustrate how these contextually co-

¹ A concept derived from the work of Boaventura de Sousa Santos, and explicated in more depth in Section 2.9.

² I draw on Karin Knorr Cetina's articulation of epistemic cultures, and describe this more carefully in Chapter 2.

produced frameworks might contribute to the reclamation of scientific inquiry as an act performed within the commons, towards the wellbeing and communal reframing of the common good. I begin the chapter by providing a broad overview of the field of citizen science, as described in the literature. What is presented in this chapter formed part of my initial literature review, and so reflects my early interests as I began this study (Chapter 5 provides a more robust and critical reading of the literature).

When attempting to determine how we go about resolving problems in the world, Santos charges us to ask ourselves, “on the basis of which knowledge or epistemology are these problems to be formulated?” (Santos, 2004:12). This question sits at the heart of the epistemological approach in this study. I am concerned with understanding how we produce knowledge, learn and take action together in response to social-ecological risks in contemporary society. Under-labouring this is an interest in how we formulate social-ecological risk in the first place, and emerging from this formulation, an interest in epistemic activity in theory, literature and practice. To begin this work, I start by framing the specific vantage point from which the rest of the thesis is launched - one which centres as the primary interest of knowledge production, an interest in the common good. The bulk of this chapter is dedicated to the work of establishing my epistemic vantage point.

To begin, I foreground a purposeful relational perspective which recognises and affirms the relations which unify social and ecological worlds into one single world (Bookchin, 1982). This perspective is developed throughout the thesis. Next, I argue for the centring of the common good (and therefore, social-ecological justice) at the heart of knowledge production, and expand this proposal to the notion of ‘commoning’ (Linebaugh, 2008) as a specific form of collaborative activity - in this case regarding learning and knowledge production. Together, these two ideas establish a specific vantage point for the remainder of the thesis - one which distinguishes it from more normative articulations of citizen science as a tool for collaborative scientific knowledge production. From this vantage point, I intend to trouble dominant framings within the knowledge economy which engage scientific ‘truth’ as the *only* basis of legitimation for knowledge work, and certification and accreditation of legitimate knowledge producers and products. Arguing for ‘knowledge production as a common good’ opens up the space to consider more complex bases of legitimation for what counts as valid knowledge as argued

more deeply in Chapters 2 and 3. It also calls for a reframing of how and why we engage in knowledge production activities.

1.2. Citizen Science as a Field of Epistemic Activity

Around the world, volunteers work together, sometimes with scientists, sometimes in government projects and sometimes contesting official knowledge coming out of public institutions. They monitor air quality, water pollution, river health; they count species of birds, insects, fish, coral, mammals and plants; they challenge municipal bylaws and band together to influence and shape national policy; they provide a mechanism for participatory democracy and contribute to national resource management. These groups of people work locally, in their communities, or connect into national and even international communities, all working to build common knowledge towards a shared interest, a shared risk or concern. Increasing numbers of communities at risk have worked with scientists, who are part of those communities, to collect alternative sets of data and legitimate their concerns about environmental degradation and the resulting impacts on community health. Scientists have discovered the power of leveraging volunteers to collect data, and governments a similar power to meet their environmental governance mandates. As new systems of citizen science become established, many governments are integrating such approaches into formal governance systems, and increasing numbers of scientists are seeking to leverage citizen power to extend the reach of potential research studies. In South Africa, at any one time, a group of volunteers might be out monitoring rare plants and informing biodiversity governance, collecting data about water pollution and advocating for more stringent mining regulations, rescuing endangered toads at risk of becoming roadkill, tracking endangered birds migrating across the continent, or counting jellyfish as a form of ocean monitoring, to name a small selection.

It could be argued that the primary intention of any citizen science project is to generate knowledge, whether it be knowledge to support advocacy movements, inform research studies, support the governance of environmental resources, or simply to enable people to deepen their relationships with the ecosystems within which they reside. Knowledge generation is the common thread that ties all forms of citizen science together, be they medical sciences, space sciences or earth sciences. Citizen science cultures then, are primarily epistemic cultures. While there are diverse and prolific fields of space and medical science-related citizen science projects,

my primary interest in this study are those projects specifically dealing with social-ecological risk within the earth sciences. Also excluded are the computer-game-based citizen science projects such as protein folding. While these fields of citizen science undoubtedly contribute to the development of knowledge in response to social-ecological risk, they are less established in South Africa, and fall beyond the scope of research in this thesis.

A more updated and extensive review of the field of citizen science is presented in Chapter 5. This section was written in the early stages of the thesis, and provides an initial introduction to the field, which is more critically engaged in Chapter 5.

1.2.1. Citizen Science as an Approach to Scientific Participation and Learning

At its most basic level, citizen science (also called networked, crowd, or community science, among a range of other names - see Figure 2) engages citizen-volunteers in collecting scientific data and engaging in scientific research (Silverton, 2009; Dickinson et al.³, 2012). Definitions of citizen science are reviewed more extensively in Chapter 5.

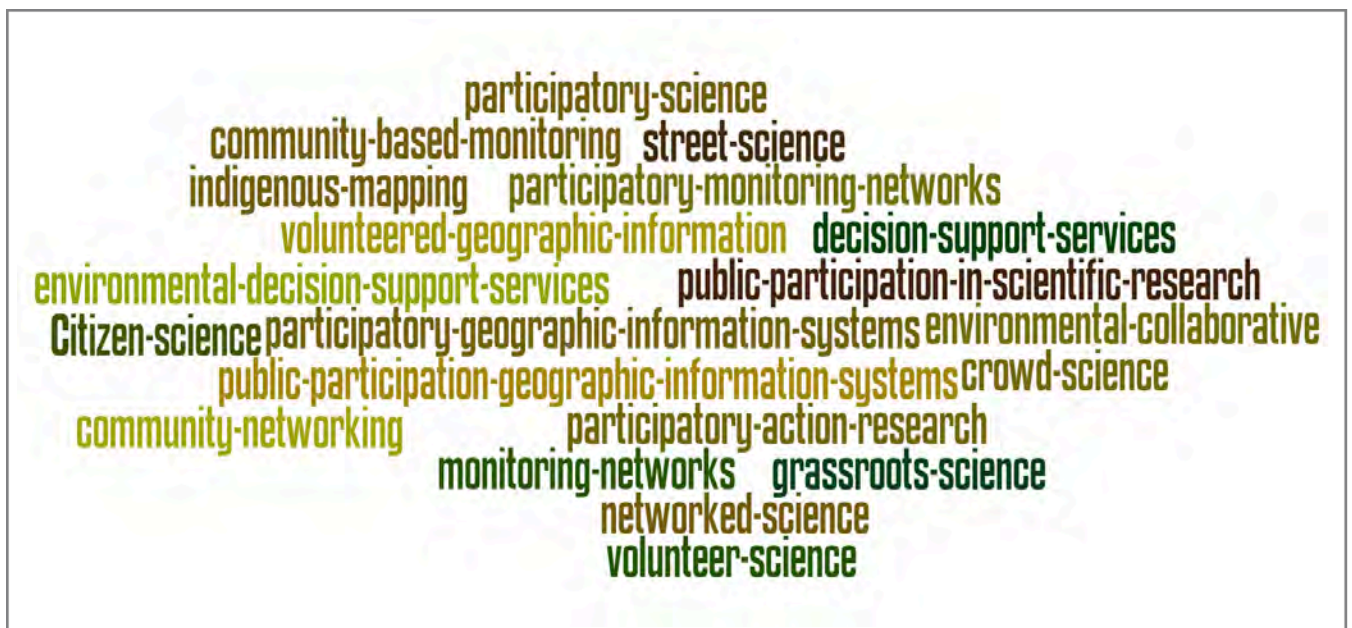


Figure 2: Word-Cloud of Descriptions Associated with Citizen Science

There is a rapid growth in the number of citizen science projects with a social-ecological interest; these projects are being mobilised in a variety of ways across a range of social contexts, resulting in an increasingly diversified field of praxis. Within these projects, citizens are being drawn into a range of different scientific activities, including species, weather, and disease

³ Dickinson, J.L., Shirk, J., Bonter, D., Bonney, R., Crain, R.L., Martin, J., Phillips, T. & Purcell, K.

mapping (e.g., Haklay, 2013); risk assessment and disaster recovery (e.g., McCormick, 2012; Gao, Barbier and Goolsby, 2011); natural resource management and policy development (e.g., Backstrand, 2003; Irwin, 2001; Irwin, 1995); ecosystem monitoring and resource co-management (e.g., Goldin et al., 2021⁴; Taylor et al., 2021⁵; Thornton & Leahy, 2012;); and advocacy and social mobilisation (e.g., Ottinger, 2010; Brown et al.⁶, 2004; Irwin, 1995). There are also citizen science projects emerging that respond specifically to different forms of socio-ecological risk such as climate variability, water pollution, and biodiversity loss (e.g., McCormick, 2012; Dickinson, Zuckerberg & Bonter, 2010; Irwin, 1995). Examples of citizen science projects include the [Audubon Christmas Bird Count](#), which in 2020 will have run for 120 years, and the [Protea Atlas Project](#), which ran from 1991 to 2008 (i.e., until the atlas was complete) (temporally arranged projects); [Galaxy Zoo](#), a global project focusing on classification of galaxies, and the [Madison Stream Team](#), which focuses on the Madison, Wisconsin (U.S.A.), watershed (Devictor, Whittaker & Beltrame, 2010) (spatially arranged projects); and [Evolution MegaLab](#), designed for schools, and [OPen Air Laboratories](#), which provides resources for amateur and expert naturalists across a wide range of ages (socially arranged projects). There are accounts of even older forms of citizen science, including the Chinese tracking of locust outbreaks reported to have occurred over at least 3500 years (Tian et al.⁷, 2011) (as an example of long-term risk monitoring), and cherry blossom festival monitoring across 1200 years in Japan (Primack, Higuchi & Miller-Rushing, 2009).

These initiatives extend across multiple scales, including temporal, spatial, and social scales, and engage in a diversified range of scientific and social practices. Projects and their attendant activities are heterogenous in nature, and project reports reflect this diversity in multiple ways. For example, Silverton (2009) talks about ‘hypothesis-driven research’ and ‘volunteer mapping and monitoring research,’ whereas Devictor et al. (2010) describe programmes with ‘specific targets’, ‘taxonomic groups’, and ‘ecological level’ foci. Dickinson et al. (2010) differentiate between ‘organismal monitoring’, ‘environmental monitoring’, and ‘non-ecological projects’.

⁴ Goldin, J., Mekomela, R., Kanyerere, T., & Villholth, K. G.

⁵ Taylor, J., Graham, M., Louw, A., Lepheana, A., Madikizela, B., Dickens, C., Chapman, D.V. and Warner, S.

⁶ Brown, P., Zavestoski, S., McCormick, S., Mayer, B., Morello-Frosch, R., & Gasior Altman, R.

⁷ Tian, H., Stige, L. C., Cazelles, B., Kausrud, K. L., Svarverud, R., Stenseth, N. C., & Zhang, Z.

Citizen science approaches are well suited to social-ecological learning because they bring citizens into direct interaction with social-ecological challenges within their local contexts. There are a great many citizen science projects established internationally, and growing numbers of programmes appearing within southern Africa more specifically. Citizen science leverages global citizenship to collect and analyse scientific data. Open inter-active portals provide public-access interfaces, offering monitoring and data collection tools. In general, participating disciplinary scientists design studies and analyse data, and citizen volunteers provide focused information, while accessing communities of shared interests. Many citizen science projects offer information resources, acknowledgement badges and access to processed data for contributors as well as spaces for social engagement with others sharing similar interests.

Citizen science as a form of practice has a well-established history (Silverton, 2009). Some of the oldest reported programmes include: Locust monitoring in China over 3500 years (Tian *et al.*, 2011); cherry blossom festival monitoring across 1200 years in Japan (Primack, Higuchi & Miller-Rushing, 2009); (bird-strike data collected by lighthouse keepers in 1880 (see for example, Ducey, 2009; Dickerson *et al.*, 2012); the National Weather Service Cooperative Observer Programme (NWS-COOP) in 1890, (Scripa & Morrefield-Lang, 2013; NWS-COOP, 2013); and the National Audubon Society Christmas Bird Count in 1900 (NAS, 2013). Even earlier, biological data were collected during the era of colonisation, with field assistants collecting biological samples and returning them to European scientists (Silverton, 2009).

1.2.2. The Current Context of Citizen Science

Sharples *et al.*⁸. (2013) identify citizen inquiry among the top ten innovative online pedagogies already in currency (although not yet mainstreamed within education). In such cases, citizen science projects are enhanced through active participation and iterative feedback from the communities engaged in them. Citizen science projects also leverage a range of technologies identified by the latest technology horizon-scanning reports forecasting mainstreaming into educational use. These include public sector data, mobile technologies, open content and applications (JISC CETIS, 2011); and cloud computing, mobiles, collective intelligence, open content and visual data analysis (Johnson *et al.*⁹, 2011). These reports point to rapid adoption of

8 Sharples, M., McAndrew, P., Weller, M., Ferguson, R., FitzGerald, E., Hirst, T., & Gaved, M.

9 Johnson, L., Smith, R., Willis, H., Levine, A., & Haywood, K.

online citizen science platforms from both pedagogical and technological viewpoints, and reflect the rapid increase in online citizen science and community science portals and programmes both internationally, and within southern Africa recently. Citizen science projects have become common within the natural and physical sciences, and target elements of the natural world at 'the scale of human experience' (Miller, 2005). Areas of practice include space and earth sciences (Odenwald, 2018), social-ecological or environmental sciences (see for example, Silverton, 2009; Irwin, 1995), and health sciences (see for example, Swan, 2012; Brown *et al.*, 2004).

Modern citizen science still draws on the methods and processes developed within earlier traditions, complemented by emerging trends of:

- Data collection evolving from physical species sampling to paper-based observations to current combinations of paper-digital or purely digital data collection supplemented by increasingly sophisticated audio-visual technologies expanding and enhancing observation data, as well as data collection via low-cost remote sensing equipment;
- Data-sharing and analysis practices moving from a) expert (scientist) ownership and manual analysis of data, historically available to the scientific community, towards b) co-owned/open data sources analysed by scientists using a variety of computational programmes and data visualisation tools, with more public dissemination of research findings (e.g. graphs, maps, etc.), and / or c) collaboratively analysed data / project-facilitated public analysis of data (e.g., where individual users create data visualisations using embedded data and tools (see Bonney *et al.*¹⁰, 2009a; Nov, Arazy & Anderson, 2011).
- Data ownership and knowledge accreditation slowly shifting between scientists owning generated data and associated scientific findings towards co-creative approaches, where citizens become recognised as knowers, and co-author or share in accreditation of research findings (a good example is the GalazyZoo project and the Cornell Laboratory of Ornithology's (CLO) (2007) data-openness policy, through the Avian Knowledge Network) (see Bonney *et al.*, 2009a; Nov *et al.*, 2011).

Although these newer processes are beginning to emerge within citizen science projects internationally, they are not yet the norm of practice. Many citizen science projects still adopt

10 Bonney, R., Ballard, H., Jordan, R., McCallie, E., Phillips, T., Shirk, J., & Wilderman, C. C.

more traditional approaches as outlined in the first two bullets above (for reflections, see Bonney *et al.*, 2009a; Silverton, 2009; Nov *et al.*, 2011; Stodden, 2010).

1.2.3. Considering the 'Why' of Citizen Science: Four Purposes

A review of the international literature provides insight into the general drivers of citizen science projects. Citizen science projects tend to adopt one or more epistemic purpose(s). Almost all of the papers reviewed in this study (see Chapter 5) make reference to one or more of the following epistemic purposes:

- Scientific Research – survey data collection and hypothesis-testing (more rare) linked to scientific investigation (Conrad & Hilchey, 2011; Silverton, 2009);
- Environmental Monitoring – monitoring of natural resources, often focused on a local scale, sometimes forming part of wider networks of monitoring dominate this area of practice. Many water catchment projects fall into this category, as do climate change and pollution monitoring projects (Bonney *et al.*¹¹, 2009b; Conrad & Hilchey, 2011);
- Advocacy – most often local projects, born out of social / environmental crisis, with a focus on advocacy (Conrad & Hilchey, 2011; Ottinger, 2010; Irwin, 2001; Stodden, 2010).
- Education – very few citizen science projects are established first and foremost as educational programmes. Instead, education forms implicit and assumed outcomes of many, if not all citizen science projects (Bonney *et al.*, 2009a; Bonney *et al.*, 2009b; Silverton, 2009).

1.2.4. Substantiated Outcomes and Impacts of Citizen Science Projects

Vast arrays of diverse impacts have been attributed to citizen science projects. These include:

- Increased project-related knowledge by participating citizens (Bonney *et al.*, 2009a; Bonney *et al.*, 2009b; Trumbull *et al.*, 2005; Evans *et al.*¹², 2005);
- Increased science literacy across various levels (Trumbull *et al.*¹³, 2000; Bonney *et al.*, 2009a; Conrad & Hilchey, 2011; Silverton, 2009; Stodden, 2010; Evans *et al.*, 2005);

11 Bonney, R., Cooper, C. B., Dickinson, J., Kelling, S., Phillips, T., Rosenberg, K. V., & Shirk, J.

12 Evans, C., Abrams, E., Reitsma, R., Roux, K., Salmonsens, L. & Marra, P. P.

13 Trumbull, D. J., Bonney, R., Bascom, D., & Cabral, A.

- Increased or improved relationships with the natural environment (Silverton, 2009; Evans *et al.*, 2005);
- Improved digital literacies (Bonney *et al.*, 2009a);
- Community-building – both physical and virtual communities form and grow in a variety of ways, with citizen science projects and activities acting as the common interest around which the community revolves (Bonney *et al.*, 2009a; Bonney *et al.*, 2009b; Conrad & Hilchey, 2011);
- Cross-sectorial collaboration – increasing numbers of citizen science projects work in cross-disciplinary groups. This is because historically, one of the most significant challenges to environmental problem-solving has been a fragmented and disjointed approach to scientific research and social action-taking (Bonney *et al.*, 2009b);
- Large-scale collection of scientific data across larger temporal, geographical and sample-intensive scales than would otherwise be possible (Conrad & Hilchey, 2011; Silverton, 2009);
- Improved validity and rigour of some elements of data quality linked to digital geo-tagging, and availability of cost-effective and quality audio-visual recorders has enabled strengthening of what has in the past been perceived as untrustworthy data collection processes by volunteers (Silverton, 2009); and
- Environmental justice and social justice advocacy resulting in changing of bylaws, challenging of environmental rulings, and evaluation of standards (Ottinger, 2010; Bonney *et al.*, 2009a; Conrad & Hilchey, 2011).

1.2.5. Notions of Citizenship within Citizen Science Projects

The term 'citizen science' is relatively new. It denotes partnership between members of the public and scientists, to generate, share and analyse 'authentic scientific data' (Conrad & Hilchey, 2011). While not explicit in the term citizen science, the relationship is assumed to be mutually beneficial: scientists are able to collect vast amounts of data over temporal, geographical and sampling-intense scales for proportionately little investment, which would be otherwise unfeasible. Meanwhile, citizens benefit by engaging in authentic science that contributes to the development of scientific literacy, is linked to personal interests, grows community-related capacities, improves relationships with both science and scientists, and strengthens citizens' relationship with the world around them (Silverton, 2009).

However, Irwin (2001) points out that the underlying assumptions and operational principles under which the notion of 'scientific citizenship' is constructed is, itself, questionable. An international literature review supports his observation, and highlights the underlying questions, 'What do we mean by citizen and citizenship?' and 'Do citizen science projects foster these forms of engagement in reality, or only ideally?' In a small data analysis activity conducted to refine the focus of this study (see 4.2.1), critical discourse analysis of extracts from three citizen science project websites in South Africa was done. This analysis clearly indicated that 'citizen scientist' and 'citizenship' were constructed in very specific ways within different projects. For example, within iSpot, citizen scientists are positioned as contributors and benefiteres of the tools provided. Citizen scientist, in this context, does not mean collaborator, scientist, co-owner, co-developer, co-producer, or initiator/co-initiator.

1.2.6. Gaps in Knowledge

Much of the international research points to and implies that citizen science as a practice leads to the acquisition of foundational scientific literacy. However, a number of issues highlight the under-researched and un-validated nature of these claims, including:

1. *Under-theorised pedagogical grounding* – The pedagogical work associated with citizen science projects is an emerging area of development in the field that this study contributes to. A large number of citizen science projects appear to be underpinned by under-theorised pedagogical practice. In many cases, there is little or no evidence that work has been done to strengthen the development of educational components of projects (Evans *et al.*, 2005). Development of educational outcomes and resources often appear unevaluated, and have contributed to narrow interpretations of learning, and learning outcomes fostered through project activities (Jordan, Ballard & Philips, 2012; also see Bonney *et al.*, 2009b). There is also often a lack of fit between individual learning outcomes, programmatic outcomes and community-level outcomes, with a focus on the latter two, conflating the three (Jordan *et al.*, 2012). This is not to say that these projects do not implicitly meet educational outcomes – rather, that this is an under-developed area of practice. Chapter 5 offers a more updated and critical review of this area of work.

2. Little educational research – Very little documented research into the educational value of such projects and their associated tools is available, either internationally or locally. There is a lack of quality scientific reporting on educational structures, development, impacts, processes and evaluation within the peer-reviewed arena, and to a large scale, within the publicly available grey literature (also see Bonney *et al.*, 2009b; Silverton, 2009; Trumbull *et al.*, 2000). Purposeful evaluation and publication of educational findings is needed to grow the field coherently (Bonney *et al.*, 2009a; Bonney *et al.*, 2009b; Conrad & Hilchey, 2011; Silverton, 2009; Evans *et al.*, 2005).

3. The role of technology in mediating citizen science engagements – Another area of interest also developing rapidly, engages with the role of technology in mediating citizen science. I have not engaged with it deeply in this study because it is out of the scope of focus, but is none-the-less, an important region of epistemic activity. Many research reports make reference to ongoing development of online resources, related to community-building, increased availability of data visualisation tools and information resources, and increased utility of remote data submission (Lintott, 2019; Bonney *et al.*, 2009b; Newman *et al.*¹⁴, 2012). However, there is less research which explicitly explores the roles and impacts of networked technologies on public engagement, community-building and educational mediation from a pedagogical perspective. With the wide scope of projects now available, insight into how these technologies contribute to different social goals is needed to better leverage online technologies in targeted and purposeful ways, rather than the random application of online resources in an ad hoc manner (see Bonney *et al.*, 2009b; Newman *et al.*, 2012; Ellstrom, 2010; Anderson *et al.*¹⁵, 2010).

4. Weak task progression within the majority of projects – Although some projects do offer multiple avenues of progressive scientific engagement, many projects still provide only basic data collection options for citizen scientists. This is especially true within primarily online models (Nov *et al.*, 2011).

While there are rapidly increasing numbers of research outputs describing the knowledge being generated through citizen science projects, and any number of critiques about the scientific

¹⁴ Newman, G., Wiggins, A., Crall, A., Graham, E., Newman, S. & Crowston, K.

¹⁵ Anderson, K., Aoki, P., Kaminsky, M. & Kuriyan, R.

legitimacy of such knowledge claims, there remains a gap in our understanding about how this knowledge is being generated. And little is known about what support might be offered to strengthen such knowledge cultures in response to social-ecological risk.

1.3. Building *Just* Knowledge

There are increasing calls among environmental educators for critically engaged citizens¹⁶ who are able to respond to the wicked problems (Rittel & Webber, 1974) and 'matters of concern' (Latour, 2004, 1999) that are now commonplace within the Anthropocene (see for example, Knight, 2015; Latour, 2014; Pandya, 2014; Leinfelder, 2013). However, the current system of validated knowledge production tends to largely work in ways that exclude citizens from knowledge work, and generally relegates them to the position of disengaged knowledge consumer. One of the results of this approach is that citizens are distant from the coherence, logic and systematic processes of knowledge production, and are therefore left in relatively weak positions to engage with and select knowledge products critically (see for example arguments presented by Latour, 2004; Bäckstrand, 2003). This is troublesome because these choices inform how they use knowledge tools and products to assist them to respond to locally embodied social-ecological concerns. Although there is ample literature that does refer to empowerment of communities through citizen science, that same literature is not well developed in its arguments about justice. Therefore, I have worked with the arguments offered by Santos, Latour, and others to in order to develop a more substantive view of justice in relation to citizen science and its empowerment potential.

It is useful to recall that the concept of 'scientist' was only coined in 1833/1834 by William Whewell (Fara 2009). The term was coined to signal a shift in the way the study of natural phenomena was increasingly being seen as distinct to other forms of knowledge, and has since served to formalise and professionalise scientific enquiry beyond its initial scope of the natural sciences. It has also resulted in a division between everyday acts of enquiry from what is considered 'science', and the formalised work of scientists. At the same time, cultures of knowledge production have seemed to become matters of cognitive and technical procedure which increasingly work to exclude other forms of social-scientific investigation (Cetina 2007).

¹⁶ The term 'citizen' is contentious and highly debated, and while I will engage with it further in Chapter 5 as it specifically relates to citizen science, I use it here and more broadly in the thesis to refer to a global citizen - one who is a member of the web-of-life on planet earth - rather than in a nationalist-legal sense of the word.

Leach, Scoones and Wynne (2005) signal this contentious enclosure of science, noting that contemporary framings of science either expect citizens to engage passively with scientific expertise or to participate through institutional channels designated for citizen participation. As a counter-note to the professionalisation of science, Stirling (2005), Santos (2007) and Visvanathan (2005) argue for the 'opening up' of science and processes of scientific engagement to increase accessibility, shift the 'burdens of persuasion', enable grassroots critiques of science, and support plural visions of the world we inhabit together.

Santos takes this argument further, claiming that there can be "no global social justice without global cognitive justice" (2007:10). He argues for a knowledge system that embraces epistemological diversity, and which, he maintains, is better able to respond to real-world embodied risk within context because it makes possible other - currently largely invisible - interventions within the social-ecological world (*ibid*). He notes that,

[t]hroughout the world, not only are there very diverse forms of knowledge of matter, society, life and spirit, but also many and very diverse concepts of what counts as knowledge and the criteria that may be used to validate it (*ibid*:12).

What Santos proposes is the articulation of a knowledge system in which marginalised knowledge systems that have been rendered invisible, religious or folkloric are reclaimed into a more complex 'ecology of knowledges' (*ibid*). In such a system, knowledge is validated in terms of its' ability to respond to embodied risk (Latour, 2004; Santos, 2007).

Such reframing calls for tools that enable us to engage with knowledge production within and outside of the mainstream or modern knowledge economy, and in ways that take account of scientific activity outside of the formal institutionalised practices of scientific knowledge production. It calls for the formation and strengthening of epistemic cultures that foreground the creation of situated, reconnected, and embodied knowledge production practices, which provide viable and robust alternatives to institutional knowledge production practices. The context of knowledge production as outlined above raises three preliminary questions:

1. What constitutes valid knowledge in the context of embodied social-ecological risk?
2. Who is considered a valid knowledge worker/producer in the context of embodied social-ecological risk?, and,
3. What kinds of epistemic cultures are needed for wider participation in knowledge production activities in response to contemporary social-ecological risk?

While this chapter cannot hope to fully address these questions, they do provide an entry point into engaging with the epistemic cultures of citizen science projects as sites within which these questions can be explored.

1.3.1. A clarification of conceptions of justice leveraged in this thesis

I primarily draw on three conceptions of justice in relation to the common good, which are epistemic, contributory and distributive justices. While each of these forms of justice are articulated in various ways within a range of literature, here I mean them quite simply, and in relation to collective acts of knowledge production.

Epistemic justice:

Although Santos's (2004) cognitive justice works are foundational to much of the work in this thesis, I diverge from his conception of cognitive justice, and choose instead to use epistemic justice. Where cognitive justice for me, speaks to justice between cognitive knowledges, epistemic justice lifts this meaning towards recognition for the need of justice between different forms of knowledge - be they cognitive or other ways of knowing the world (such as embodied, spiritual, intuitive, and others). Santos's arguments speak more strongly to this second form of knowledge-related justice, even as he leverages the term 'cognitive justice' in his work, so I take my replacement of the term as a minor concept expansion of his own.

The meaning I centre is one which combines Fricker's hermeneutical and testimonial conceptions of injustice (see Fricker, 2007), and expands beyond them to encompass Santos's (2004) analyses of cognitive injustice, and the call for ecologies of knowledges (Chapters 2 and 3 engage this topic in relation to knowledge production more specifically). While my argument does not follow Fricker's paths of moralising virtue, it does speak to integrity in common knowledge production, once again, aligning me more strongly with Santos's conceptualisations of cognitive justice and his analyses of systems which both make present some knowledges and simultaneously absent others (2004; 2.9). The call for epistemic justice also speaks to Spivak (1988) and Sharp's (2008) work on subalternism, and the marginalisation of ways of knowing which are rendered strange and incoherent within the global west, even though it does not centre decolonial theories.

As the knowledge interest in this thesis is the building of common or collective forms of knowledge, Appendix 11 provides a think-piece on *rigour-as-integrity*¹⁷, speaking to strengthening the ways in which we might collectively build knowledge rigorously (after Santos), rather than cultivating individual forms of epistemic virtue (after Fricker). The conceptualisation of epistemic justice in this thesis then, is one which brings focus to issues of justice between diverse forms, types and ways of knowing the world, cognitive and otherwise.

Contributory and distributive justices:

In the context of this thesis, notions of contributory and distributive justice might better be perceived as two aspects of the same justice concerns. In relation to knowledge production, this combined interest in justice brings focus to the state of epistemic access enabling, constraining, regulating and systematising epistemic contributions into diverse forms, levels and systems of knowledge production. It also raises questions about the distribution costs and benefits arising through systems of knowledge production. Questions of distributive justice are questions of whose resources are mobilised towards knowledge production, and how are those resources are recognised, as well which benefits arise through production systems, and how those benefits are distributed. These interests go beyond simple systems of participation or universalised benefit which dominate public participation discourse, towards a deeper interest in participation which is epistemically just and co-produced in ways which generate common goods that all (human and other-than-human) might benefit from¹⁸.

While most research on distributive justice focuses on economics and systems of welfare, I leverage the term in deeper ways here. Included are concerns about resource and material benefits, but as important is recognition that there is value in being able to story the world in ways which reflect ones personhood and culture while pursuing epistemic interests which shift beyond the hegemonic, dualistic, techno-scientific, or neoliberal accounts of democracy which dominate 'collective culture'. Distributive justice without contributory justice - the epistemic access to story the world ways that are coherent with one's own epistemologies - is seen as partial at best, and symbolically and materially violent at worst. Choosing which knowledge to

¹⁷ This think-piece emerged through the work of this thesis.

¹⁸ While this thesis touches only minimally in expanded systems of justice which encompass other species and the Earth as participants, due to space and focus constraints, questions of contributory and distributive justice certainly encompass them. This is touched on briefly in the critiques presented in Chapter 3, and I hope to give more dedicated time to thinking about such justice implications in the future.

build, how to go about producing such knowledge, and importantly, how such knowledge might be leveraged in response to situated and universalised risk are included as pertinent dimensions of contributory justice.

Conceptions of epistemic, contributory and distributive justices are intrinsically connected in the arguments which follow. Systems of distribution which are traditionally separated out of knowledge production become troublesome if we have not first asked how knowledge was produced, and on the basis of whose knowledges, systems of distribution are being framed. Underpinning these notions of justice is an interest in radical democracy which enables both deliberation and participation (which are consensus-building strategies), but also divergence, contestation and conceptions of equality which challenge hegemonic tendencies to homogenise. (3.3. provides a stronger orientation to this argument).

Strengthening justice as a form of collective action

These three conceptions of justice speak to a recognition that dismantling structural injustices are in themselves, acts of commoning (Young, 2011; 2005; 2001a; 2001b). Young argues that structurally manifest injustices exist,

when social processes put large categories of persons under a systematic threat of domination or deprivation of the means to develop and exercise their capacities, at the same time as these processes enable others to dominate or have a wide range of opportunities for developing and exercising their capacities (Young, 2006:114).

In response, Young calls for a social connection model that is forward-looking, arguing that there is an ethical imperative and responsibility incumbent on all those whose actions make contributions to structural processes and systems which manifest as structural injustices, to contribute to remedying those injustices (*ibid*). Through this piece of research I speak intend to this call.

1.4. The (Ad)vantage of Social-Ecological Conceptions of Risk

As an environmental educator, my professional interest is in supporting learning in response to environmental risk. In the research community of practice in which I am situated, we have come to understand environmental risk as emergent from social and ecological injustices - the social and ecological are irreducibly implicated in, and embroiled with each other. This contrasts with many mainstreamed conceptions of the 'environmental crisis' which position humans as separate from the Earth System.

I therefore begin the work of developing a vantage point from which to engage with the field of citizen science through the relational articulation of social-ecological risk. The concept of social-ecological risk here is purposeful and contrasted with mainstreamed notions of 'the environmental crisis', and is informed by specific conceptions of social-ecology, described below. The framing of 'environmental crisis' I am resisting and seeking to reframe is one which dominantly takes as its starting point, the first Industrial Revolution¹⁹, and which is subsequently defined through the hegemonic rationality and politics arising from colonisation - it is a teleological concept which articulates environmental destabilisation sequentially and dualistically. Such origins tend to consider human impact on the Earth System as homogenous; they therefore fail to consider impacts on peoples who were themselves designated as part of nature, the diversity of social-ecological relationships enacted in various places, or the imposed hegemonic cultures arising through colonisation, and the subsequent social-ecological impacts. My position is informed by the three immanent critiques of knowledge production presented in Chapter 3, which include:

- *Critique 1: Knowledge production within modernist western sciences: A critique of ontological dissonance*
- *Critique 2: Science and its publics: A critique of knowledge flow, and*
- *Critique 3: The construction of environmental risk within the Anthropocene: A critique of the capitalist narration of risk.*

Rather, I argue for a conception of social-ecological risk which centres our relationships *both* with each other *and* the wider Earth System as iterative, and includes as of interest, how those relationships themselves have worked to destabilise both the Earth System and historical through to contemporary social systems. In the latter framing, an analysis must encompass the very definition of the 'environmental crisis', and includes those social systems that led to the 'beginnings' of the crisis itself. Here both social and ecological justices are of interest, and are intrinsically embroiled in each other. It also requires as part of any response, the absenting of those forms of relations resulting in contemporary social-ecological risk, and the re-imagination of social-ecological relationships going forward.

¹⁹ All mentions of the Industrial Revolution reference the first industrial revolution, unless otherwise stated from hereon.

I draw on Bookchin's conception of social-ecology (1982) to inform my understanding of social-ecological risk. Bookchin's critical thesis foregrounds the iterative and co-constituting relationships between humans and nature, viewed within a complex system of interdependences that are both historically situated and emergent (*ibid*). Bookchin argues for the conscious development of these relationships, with the purpose of articulating and supporting diversity, freedom and the common good (*ibid*). His theory also foregrounds collective action and cooperative social movements that disrupt and challenge hierarchical social systems and institutions in pursuit of the common good. Drawing on Bookchin's conception of social-ecology, a social-ecological crisis then, encompasses both the social and ecological impacts of contemporary life and the risks such inter-relationships produce, including the very relationships that compose it.

A limitation of Bookchin's conception of social-ecology is that it assumes the biological nature of 'nature', and the conscious and also biological nature of humans; where the natural system enacts biological relationships, and the human system enacts both biological and conscious relationships. Although he argues strongly against capitalist systems of anthropocentric dominance, and against dualistic reasoning, Bookchin's allocation of consciousness to the human realm alone seems to tie him to the roots of dualistic reasoning and anthropocentric dominance and supremacy within the web-of-life²⁰. Of more immediate relevance to this study is a concern that he also seems to perpetuate this view through his presentation of consciousness as a state of logic and rationality, through which Bookchin privileges rational analysis over other ways of knowing the world (embodied, intuitive, emotional or spiritual, for example). There is little engagement with the intrinsic values within the other-than-human elements in the web-of-life, nor with other ways of being and knowing within the human realm; this lends itself to the reduction of relationships towards instrumental relations, rather than other forms of relating, knowing and being. In Chapters 2 and 3, I attempt to challenge this ontology, and expand it into a more coherent critique of dualistic and anthropocentric epistemologies.

In the meantime, the concept of the social-ecological crisis in this study is one which:

- foregrounds the interdependence and iterative nature of humans within, and as fundamentally part of the web-of-life (drawing on Bookchin, 1982; also see Moore, 2017);

²⁰ While I do not explicitly argue against this framing in the thesis, I do not concede this point to Bookchin either - rather I set it aside as being beyond the immediate scope of the thesis, beyond some preliminary discussion in Chapter 3.

- considers the significance of the historical roots of the social-ecological crisis, even beyond industrialisation (drawing on Bookchin, 1982; also see Moore, 2017; O'Donoghue, 1993).

It also:

- elevates the pursuit of the common good through commoning activities which embrace diversity and freedom (drawing on Lotz-Sisitka, 2017; Santos 2016a; Bookchin, 1982; also 1.5.4), and
- in direct contrast to Bookchin (1982), argues for ontological and epistemic justice, and considers the value of multiple ontologies and forms of knowing the world in pursuit of both freedom, and the common good (see Santos, 2016a, 2016b, also 2.9).

In terms of an interest in knowledge production and learning, adopting a relational view of social-ecological risk brings to the fore an interest in epistemic relationships and their implications for social-ecological justice. In addition, accounts of social-ecological risk which underpin our understanding of the social-ecological crisis also need to be understood in terms of the social-ecological relationships which constituted them historically, and continue to constitute them currently. This inquiry forms a key aspect of this thesis.

1.5. Foregrounding an Interest in the Common Good

How knowledge is framed significantly informs the form of an epistemic culture, and what is privileged, silenced or 'othered' through this formation. Cetina (2007) argues that economic definitions of a knowledge society currently dominate. Knowledge is centralised as a value and wealth-creating productive force, to the extent that it increasingly replaces capital, labour, and even natural resources within economic settings (*ibid*). Both knowledge and education (as a constituting vehicle of knowledge production) are widely considered to be 'public goods', and the institutional practices supporting this view have become normalised and routinised within both. In this section, I argue that re-framing both of these as 'common goods' provides a more versatile and socially just framing, and lays the foundation for more authentic accounts for how knowledge and education systems are constituted. I aim to illustrate how framing citizen science projects and their epistemic cultures from a common good perspective enables a greater versatility and deeper forms of justice than their framing as public goods. This section lays the foundation for a more explicit argument for ontological and epistemic justice presented in Chapter 2. While providing a broader engagement with notions of private and common goods,

I attempt to bring the argument back to implications for knowledge production and learning throughout.

Typically, three primary forms of 'good' have been articulated between economic and political sciences, including private, public (and recently, global public) and common goods. 'Goods' in this context refers to something (service, social activity, material item, cultural artefact or practice, etc.) that is of positive benefit to those who use or engage with it.

1.5.1. Private and Public Goods

Public and common goods are foregrounded within this study, so I will provide a conceptualisation of them as they relate to this study here. For clarity, private goods are easy to designate in that they are considered to be rivalrous, excludable and exhaustible because they cannot be reused by the general public, have controlled and limited access, and are used solely by the private parties who have purchased them (Deneulin & Townsend, 2007).

The concept of public goods is most often leveraged within economic and public administration discourses. In theory, public goods are goods that are both non-rivalrous (one person using it does not diminish its availability for others to use it) and non-excludable (a person cannot be excluded from its use). There is some degree of conflation between the economic framing of the term (most often related in terms of state mandate) and the political framing, which is more closely aligned to those things which contribute to shared social benefits. Education or public infrastructure are often referenced as public goods, as are knowledge, languages, and water or air, for example. Exploitation of public goods are also prone to result in public 'bads' (think climate change, corruption in public service provision, water pollution, resource over-utilisation and ecosystem degradation). However, the realisation of the concept is ambiguous in that there are very few real examples of what are termed 'pure' public goods - for example, public water supply is subject to water levies and infrastructure which often exclude lower income or rural social brackets and are reliant on catchments that are subject to often competing public, industrial, agricultural and private interests. Two additional examples speak more directly to the central work of this thesis:

Example a) while all children in a country might have the right to free basic education through state provision (as is the case in South Africa), that does not mean that the point of provision is a choice, is accessible, or is of equal quality across the state system.

Example b) in the case of scientific knowledge, although scientific activity is often funded through public funding systems, and is framed as a public good, the structure of the knowledge economy acts to exclude through privatisation (for example, Intellectual Property laws, enacted through the production of closed journals and books), language, and onto-epistemic representation. Put another way, who is able to legitimately contribute, and who has access to knowledge products is highly regulated, with much of the knowledge generated through public funding ending up within the commodified private market.

However, as Maskus and Reichman²¹ (2004:292) point out,

the regulation of knowledge goods in national markets impinges on the provision of other public goods - health, education, scientific research, agriculture and the environment - in ways that were virtually unknown to previous generations. The centrality of innovation in dynamic developed economies has fostered a process of 'enclosure' and privatization that increasingly threatens the provision of those other public goods that citizens take for granted and identify with the very exercise of state sovereignty.

Where Maskus and Reichman (2004) describe these processes in terms of their production of 'anti-commons effects²²', Boyle (2003) engages more directly with this same process through the description of what he terms 'the second enclosure movement', referring specifically to networked knowledge production and commons and the problems associated with economic models based on the increasing privatisation of knowledge - an idea I engage with again later in this argument (see 1.4.3 below).

To moderate the term 'public good', terms such as quasi-public goods and impure public goods are used to indicate the spectrum between private and public goods. The concept does however, attempt to designate those resources that should in theory at least, be produced and/

21 Maskus and Reichman (2004) provide a careful argument related to Intellectual Property Rights as one of the key mechanisms facilitating the shift of public knowledge goods into private ownership regimes. Their argument especially highlights implications for the Global South in such processes, in addition to articulating some aspects of the 'democratic deficit' that this process engenders for all concerned. Their argument is particularly useful in that it highlights the market rationalities that come into play in determining whether goods should remain in the public domain or be transferred into the private sphere. What is privileged in debates in the area of Intellectual Property regulation, their argument makes clear, are economic rationalities disassociated from their relational contexts and exclusive of those values not accounted for within Capitalist economic models.

22 Also see the work of Heller and Eisenberg (1998) who describe the process of privatisation of biomedical knowledge, and put forward the notion of 'the Tragedy of the Anticommons', through which they attempt to articulate the impacts of limited access to biomedical (and other forms of) knowledge.

or managed for communal benefit. However, capitalist rationalisation is evidenced through critiques of public goods in terms of their regular framing as market failures, linked to free-riding (where consumer-benefit from the creation of a public good without their contributing to its creation is seen as an economic failure).

The concept of 'global public goods' emerged at the turn of the century in an attempt to articulate those public goods whose provision goes beyond single state provision, and which take account of multiple and future generations (Kaul, Grunberg & Stern, 1999; Deneulin & Townsend, 2007). According to Kaul *et al.*, (1999), the concept of global public goods encompasses an interest in the management of global natural commons (ozone layer, global fish reserves, etc.), global human-created commons (knowledge, heritage, etc.), and social wellbeing or political commons (such as peace, a functional open market, etc.), (also see Deneulin & Townsend, 2007).

Unfortunately, the economic rationale underpinning most discussions about public goods serve to rationalise the privileging of capital gains over other forms of value - the debate becomes one of the cost of supply versus perceived market-related returns, instead of say human rights, social justice, or environmental sustainability (for knowledge-related examples, see Maskus & Reichman, 2004; Williams, 2016a)²³. While such non-economic imperatives might well have been the incentive to establish a public good, economic rationalities ultimately tend to determine the extent, quality and commitment to their provision.

1.5.2. The Common Good

The concept of 'the common good' has some overlap with 'the public good', in that it also attempts to designate 'goods' that should be created or allocated towards communal benefit.

²³ For some discussions around the problematic of public good framings of education and knowledge, see for example, Walker (2018) who provides a more refined perspective of education and knowledge public goods; Altbach (2002) who argues against the commodification of knowledge and education; Williams (2016b) who tracks the shifting discourse of education as a public good away from collective goods towards individualised goods; Bencze and Carter (2011) who argue against the hegemonic, undemocratic outcomes of science education and the dubious of knowledge production increasingly geared towards individual elitist economic models; Shapiro (2009) who challenges us to resist an education and knowledge system directed towards economic interests which compromises the purpose of education, and instead calls on us to educate as a common good instead; Kezar (2017) who synthesises a range of issues related to Intellectual Property issues within higher education settings as they relate to the public good; Mamdani (2007) who describes the commercialisation and neoliberal reform of Makerere University in Uganda, and the implications for education and knowledge production; May (2002) who brings attention to the implications of the commodification of knowledge to society; and Radder (2017) who argues against the commodification of scientific knowledge and proposes deepening an understanding of what science as a common good might look like.

Conceptualisations of public and common goods tend to become blurred in the literature, depending on whether one is reading economic, governance, socio-political or philosophical accounts, and depending on their practical and disciplinary concerns (Riordan, 2014). Public and common goods are also often seen in conflict with each other, largely because of the dominance of market rationalities that underpin the framing of nature (as one of the largest commons) and other forms of commons (knowledge and culture, for example) as commodities within conceptions of public goods.

Douglass (1980), Lineburgh, (2008), Shiva (2016), and Moore (2017), among others, all provide an outline of the shift that occurred from common to public goods as commodified markets and capitalist systems expanded across the globe. While definitions of private and public goods are dominated by economic interests and are defined in terms of implications to the market, the concept of the common good draws more strongly on political and sociological underpinnings, and foregrounds an ethical interest in distributive justice - especially as relates to collectively inherited or co-produced resources. In many ways, the concept of the common good runs counter to that of the public good in that it requires a process of re-valuation away from capitalist scarcity-value frameworks towards other forms of value (see for example, Shiva, 2016). Drawing on its Aristotelian roots, and further developed by Aquinas and others, the term arose in relation to the governing (not necessarily by state governments) of those systems and resources that are required for 'a good life' (including for example, peace, justice, general prosperity, health, belonging, etc.) (Douglass, 1980; Deneulin & Townsend, 2007). More than this, it is concerned with more than the wellbeing of individuals, extending also to 'the goodness of life that humans hold in common' (Deneulin & Townsend, 2007:24; also see Douglass, 1980), in addition to those goods that we hold in common with other species within the web-of-life.

While private/public goods have their basis in often contentious anthropocentric relationships (see 3.4. for more detailed critique) which commodify the web-of-life towards human wellbeing, the notion of the common good lends itself to considering those goods that moderate human gain for greater social-ecological wellbeing. Additionally, the concept of the common good encompasses the relationships involved in the creation and use of resources, and the practices that are leveraged within these relationships as significant and part of both the commons and the common good. Included are both our common rights and the responsibilities we share in

order to create, promote and maintain various commons and common goods (Quilligan, 2009; Linebaugh, 2008; Deneulin & Townsend, 2007). Common goods are therefore relational, and include those relational activities which co-constitute them. Deneulin and Townsend (2007:25), note that,

the good lies in the action together which generates it [...] This is to say that the shared action is intrinsic, as well as instrumental, to the good itself and also that its benefits come in the course of that shared action. Goods of this kind are, therefore, inherently common in their “production” and in their benefits.

Drawing on this, a significant distinction between public and common goods is the reciprocal nature of common goods, where reciprocity and willing participation are significant to the formation and sustenance of a common good (Douglass, 1980); in other words, common goods are constituted through willing and reciprocal participation in them. A second distinction is that in the case of conflict between personal (or private) and common goods, common goods take precedence because they represent a greater good (compared to public-private good conflicts, where private goods are often prioritised and privileged due to the legislative structures underpinning capitalist markets).

The term is often referenced in relation to ‘the good life’, ‘*buen vivir*’, ‘good common world’ or ‘to live well’ and ‘good living’, (see Santos, 2016a; Latour, 2004; Douglass, 1980), and holds a much stronger relationship to context in that what is considered a good life varies from context to context, and can shift significantly within relatively small geographical and temporal scales. Researchers such as Lotz-Sisitka (2017), Shiva (2016), Santos (2016a), Bhaskar (2008), Vishvanathan (2005), and others, argue for social-ecological justice and a conscious shift away from commodified systems of value as integral to the work of the common good.

While some definitions of common goods include a criteria of total community agreement on what the good is, and their involvement in its creation or management (see for example, Deneulin & Townsend, 2007; Riordan, 2014), this does not account for the commoning activities (Lotz-Sisitka, 2017; Huron, 2015; and 1.4.4.) that some members of a community may engage in either on behalf of a community or in challenge to the status quo within a community within which common ‘bads’ have become evident, as is often the case within social-ecological justice work. Nor do many articulations of the common good explicitly consider or include the web-of-

life beyond its service to humans. In this study, I foreground as 'common goods', those systems, activities, and goods that affect 'a good life' for all within the web-of-life.

What a 'good life' entails varies, of course, based on a large and complex range of criteria. Common goods can be seen to conflict across geographic, social and temporal scales. To avoid the trap of conflating and reifying the common good into universal and global terms at the cost of local and contextual specificities, I suggest that it is useful to further define common goods based on their scales (as with public goods); a) local common goods for those common goods emerging and impacting at local scales; b) national common goods for those falling within nation-states and their mandates; and c) global common goods, for those concerning the global web-of-life, including future generations of life²⁴.

Quilligan (2009) also describes three spheres within the global commons including the noosphere (related to social-cultural systems and resources), the biosphere (related to biological resources and the other-than-human world), and the physiosphere (encompassing atmosphere, geosphere, stratosphere and the inorganic world). Local common and public goods can be, and often are, in conflict with global common goods in that they prioritise and privilege the local and specific over the global. At the same time, global common goods, when homogenised, can be prone to local 'bads', because they privilege the global and universal (more accurately, dominant views which come to represent what is considered global or universal), at the cost of the local or specific. There is much work to be done to develop coherent processes and tools to engage between these scales and priorities²⁵, and it is my hope that this thesis will make a small contribution toward this end in terms of its articulation of citizen science as a potential tool for knowledge production and learning as common goods. Finally, common goods are constituted through particular commons, and the commoning practices associated with them. Each of these aspects is engaged with further, below (see 1.5.4).

24 Additional conceptualisation would need to emerge to coherently form relational systems between them - while such work is beyond the scope of this thesis, I flag it here to indicate my recognition that there is work to be done to make the concepts useable within contemporary systems.

25 Here, the work of Etzioni (2014) provides some starting points into thinking about the relationships between these scales; Etzioni distinguishes between universal and particularistic obligations towards the common good. He especially considers the relationship between these two scales of obligation, arguing that they have the potential to strengthen and moderate each other if engaged with simultaneously, and in relationship to each other.

1.5.3. Tragedies of Commons and Anticommons

One of the most prominent arguments leveraged against revival of commons' is what Hardin (1968) describes as 'the tragedy of the commons', which argues against commons on the basis of degradation and exploitation due to over-consumption. Unfortunately, Hardin's work does not engage with similar processes of degradation and over-exploitation within privatised resources and publicly managed commons, which differ chiefly in that they produce ongoing degradation through *legalised* processes and formal systems of management, for the benefit of select parts of society.

However, the work of Nobel Prize laureate Elinor Ostrom (see for example, Ostrom, 2000; Ostrom, 1990) challenges Hardin's argument and makes the counter argument that there are many commons that have been co-produced and co-managed over substantive periods of time. She does not dismiss Hardin's argument of mismanagement, but instead problematises the over-accounting of the challenge as presented by Hardin and others. Challenging the move to privatise or institutionalise management of common-pool resources, her work expands the empirical base of evidence indicating that there are in fact many communities which have successfully co-managed common resources over enduring periods of time. Drawing on such successful systems of self-organisation, Ostrom's work provides an alternative approach formulated around co-governance of common pool resources that is both situated and contextually reflexive (Ostrom, 1990).

Boyle (2003) contributes to the critique of Hardin's thesis, his articulation of 'the second enclosure movement' which he contends is currently becoming manifest in relation to knowledge commons. In his critique, he argues that the enclosure of physical resource commons (specifically land-related commons such as land itself or particular types of plants on a particular piece of commonage) is markedly different to knowledge commons, and especially to contemporary networked knowledge commons in terms of the underlying nature of such commons. Where land, water, and other such commons are prone to issues of rivalry and excludability or at the least, limited use, knowledge commons do not face the same challenges. With networked technologies now becoming ubiquitous in many parts of the world, the costs of knowledge reproduction and distribution, and increasingly even knowledge production and ongoing data costs, have decreased substantively with most real costs associated with the initial

production, compared to research costs prior to the widespread availability of such research-supportive technologies (*ibid*).

Concerns related to knowledge commons centre more strongly around issues of collective action, the management of such actions, and the privatisation-associated structures that begin to impact on the collective knowledge project in detrimental ways - what Heller and Eisenberg (1998) aptly name 'the Tragedy of the Anticommons'. In their argument about biomedical knowledge, Heller and Eisenberg point to the detrimental effects of privatisation on such common goods as health and wellbeing (*ibid*). They highlight the impacts of knowledge privatisation on other knowledge workers (both current and future) who don't have access to privatised knowledge portals, who are divested of the opportunity to use privatised biomedical knowledge to engage in further potentially life-saving research (*ibid*). Their argument stands as strongly for the whole of the knowledge commons, as illustrated by Maskus and Reichman (2004).

Here, Lessig (2002) stretches us beyond the simplicity of thinking in terms of private or public towards a more layered understanding. In his analysis of 'the second enclosure movement', he pushes us to notice that the internet (which rests at the centre of his argument against growing Intellectual Property laws), is in fact made up of a physical layer, a logical layer and a content layer - each of which can, and often do, follow differing forms of control and access, - and it is *this* complexity which builds a commons. While I avoid reproducing his full argument here, it is useful to draw out a few key points: a) at the heart of the logical layer on which the internet was designed was a particular vision of freedom - one which has enabled the rapid uptake and exponential innovation occurring through it; b) the systems of commons-building enabled through the freedom-promoting logical layer of the internet have given rise to new forms of social-cultural activity, and new systems of innovation; and c) the application of property laws to control access, flow and reproduction across this system would damage the network's ability to support such innovation, ultimately instituting a state of control similar to the Christian Church in pre-enlightenment times. Boyle (2003) goes so far as to argue that privatisation actively works to exclude opportunities for peer-to-peer collaboration and co-creation, which inevitably undermines the potential of an already flourishing system (albeit often controlled) of commoning activity.

Returning to Hardin (1968) and Ostrom (2000), Boyle (2003) points out that while many advocates of commons and common pool resources, (especially when referencing such successful commons as open source software) refer to the 'free' and open (and unmanaged by implication) nature of these resources, this is in fact inaccurate; such open networked commons are in fact licensed and managed - but they are managed for openness and co-production. Open source licences have attribution clauses, share-and-share alike clauses, and a number of other mechanisms which work to manage the processes of ongoing co-production and access to such resources. In this way, they fall within Ostrom's (2000) argument regarding the success of co-managed commons. As Lessig (2002:1788) so aptly puts it, these commons are constituted of "resources that are protected by a liability rule rather than a property rule" ... "[t]he point is not that no control is present; but rather that the kind of control is different from the control we grant to property" - what Boyle (2003) describes as a price of admission based on one's commitment to contribute one's own incremental innovation into the ecology of the commons.

Boyle's paper in particular, poses a range of powerful questions for thinking about the public domain and its associated commons. He points out that what the public domain should include,

depends on why we care about the public domain, on what vision of freedom or creativity we think the public domain stands for, and what danger it protects against. The public domain will change its shape according to the hope it embodies, the fears it tries to lay to rest, and the implicit vision of creativity on which it rests (2003:62).

What arises between these arguments is a description of emerging forms of commons which rely, more than ever before, on open processes of co-production which are intrinsically and inseparably linked to well functioning commons, and which are deliberately managed to facilitate equitable forms of sharing. Where the notion of the 'public good' is built on market rationalisations managed through intellectual property regimes, the notion of 'the common good' calls on us to examine and consider knowledge production outside of, and beyond the market, and which centres an interest in social-ecological justice first and foremost. These authors push us to think about common goods in terms of the freedoms they enable, rather than their implications for limiting private access to resources.

Within this thesis, a distinction between collaborative activity privileging and resulting in commodified productivity (or knowledge products/commodities that require collective action for their constitution), and collaborative activity privileging and contributing to 'a good life', and

foregrounding an interest in social-ecological justice, is useful. While public goods are primarily concerned with distributed consumption of a good, common goods are concerned with collaborative participation in the creation of the good, in addition to a shared interest in distributed access. I therefore use 'public goods' specifically in reference to commodified productivity and its underpinning individualistic socio-economic theory (Deneulin & Townsend, 2007), and 'common goods' to refer to goods related to common wellbeing beyond the labour market, and within the context of social-ecological justice. Let me be careful to note that just because a good is considered a public good does not mean that it is inherently against social-ecological justice - rather, I am arguing that this framing lends itself more easily to privileging capitalist rationalities, which as I argue in Chapter 4, result in messy approaches to such work.

1.5.4. Knowledge Co-production and Learning as Commoning Activities

The point is that it is only in relationships, structured as necessary to enable the common action that "produces" common goods, that lives which benefit from such goods can be lived

(Deneulin & Townsend, 2007:32).

For Latour (2004), the 'work of collecting' is most important in generating the progressive composition of the good common world²⁶. More specifically, Deneulin and Townsend (2007) point out that for a common good to exist, there is a prerequisite to enable those members of a community to whom the good is relevant, to be able to participate in the practices which constitute that good - the constitution and sustenance of a common good is not possible without the collaborative practices that constitute the good in the first place (*ibid*). Linebaugh (2008:279) suggests that we need to add to our understanding of the common good, and the commons, the verb 'commoning', noting that,

[t]o speak of the commons as if it were a natural resource is misleading at best and dangerous at worst - the commons is an activity and, if anything, it expresses relationships in society that are inseparable from relations to nature. It might be better to keep the word as a verb, an activity, rather than as a noun, a substantive.

Adding to this, Amin and Howell (2016:3) call for us to revisit and re-imagine what we think the commons consists of, and propose an understanding of commoning "as a process, a contest of force, a reconstitution, and a site of convening practices". Bringing this expansion back to the

²⁶ Cetina (2007), Latour (2004) and Santos (2004) between them, leverage a range of overlapping and intersecting concepts, including '*buen vivir*', 'the common good', 'good common world', 'the good life', 'to live well' and 'good living'. My sense is that these terms are all related, and point to ways of conceptualising and articulating what I have framed as the common good. The terms go beyond materialistic conceptions of what constitutes common well-being, encompassing the web-of-life and our inter and intra-species relationships. It also encompasses past, present and future generations of life.

epistemic cultures of citizen science projects, the concept of commoning potentially reframes epistemic activity as an act of commons construction - thinking citizen science as systems of commoning, rather than as a mechanism through which volunteers contribute to hegemonic systems of knowledge production expands how we think about what makes knowledge contributions and practices legitimate. This idea is developed more deeply in the remainder of the thesis.

Extending this perspective with a particular emphasis on the importance of knowledge commons, Visvanathan (2006:167) points out that,

a commons of resources includes a commons of skills and habituses that sustain these sources of knowledge. A commons cannot be reduced to a collection of commodities or information to be patented. It is a heritage but not something one archives or museumizes or patents. It is a legacy available to all, sustained by careful use. The commons is also not a monoculture but a zone of diversity, of Vavilovian domains of skills, memories, techniques and theories, which many marginal societies employ to cope with disasters and development.

'Commoning' then, refers to those knowledges, processes and practices which individuals and collectives engage in to create, justly share, and maintain a common good (Linebaugh, 2008; Lotz-Sisitka, 2017; Gibson-Graham, Cameron & Healy, 2016); it is a relational verb that seeks to both re-constitute and re-connect social-ecological relations along a shared interest in social-ecological justice.

Huron (2015) also notes that the act of commoning does not necessarily pre-suppose the existence of a community, and that there is a dialectical relationship between commoning activities towards the creation of commons, and constituting the community related to a commons. Nor are those engaged in commoning activities necessarily socially homogenous or likeminded in their interests or relationships to a particular commons, or even in agreement over why and how to constitute a particular commons (Gibson-Graham et al., 2016). What such a community shares is the particular commons that they have in-common, rather than sharing any common relationship with their particular commons - Gibson-Graham et al. refer to these as 'commoning communities' who are also communities that common across geophysical scales and temporalities (*ibid*). Commoning, therefore, does not call for homogenising activity, nor complete consensus; rather it calls for a range of potentially diverse individual and collaborative activities which work together to re-imagine, co-constitute, co-create and maintain a particular commons across geographical and temporal scales.

Of particular interest in this thesis is the role of knowledge co-production and learning as commoning activities - an area that Lotz-Sisitka (2017) notes is currently under-theorised. At present, there is some discussion related to education more broadly, as a common good. The UNESCO 2015 report, *Rethinking Education: Towards a global common good?*, for example, forwards the proposal that we need to rethink the purpose of education, traditionally framed as a public good towards a common good. Instead, the report argues that "the creation of knowledge, as well as its acquisition, validation and use, are common to all people as part of a collective societal endeavour" (UNESCO, 2015:11, emphasis in original), and that education "must be about learning to live on a planet under pressure" (2015:3). The report emphasises a humanising approach to education which is "based on respect for life and human dignity, equal rights, social justice, cultural diversity, international solidarity, and a shared responsibility for a sustainable future", (*ibid*, 2015:10). Such an approach calls for us to deeply interrogate and review the assumptions underpinning our notions of what it means to be equal, to share responsibility, and at the same time, to be culturally diverse in just ways.

The concept of the common good in the *Rethinking Education* report seems to encompass three distinct areas: a) the provision of education itself as a common good; b) education as a vehicle for promoting and distributing common goods; and c) education as commoning, involving co-engaged knowledge production and learning towards the constitution of common goods. The report develops policy imperatives described in its predecessors, *Learning to Be: The world of education today and tomorrow*, known as the 'Faure Report' (1972), and *Learning: The Treasure Within*, known as the 'Delors Report' (1996), both of which were influential in framing the educational mandates of many countries. Through this latest report, the idea of 'the common good' as a significant one for education is gaining traction, and the need to engage with all three areas constituting the common good within the report is emerging (see for example, UNESCO's current 'Futures of Education Initiative').

Speaking specifically about learning in response to social-ecological risk, Lotz-Sisitka (2017) argues for educational approaches which support commoning grounded on emergence within context. For Lotz-Sisitka, "commoning can be a way of not only being in the world but also of becoming, that can be realised in processes of transformative praxis in collective learning settings", (2017:69). Her proposal foregrounds an ethics which interrogates and re-imagines power in the service of the common good, and mutual wellbeing for the human and the other-

than-human world. Importantly, Lotz-Sisitka argues for forms of emergence which are co-produced, arise from and are useable and useful within contexts of situated risk, and take account of the relational character of the world (*ibid*).

1.5.5. Implications for Framing Citizen Science Activity as Commoning Activity

In this section, I have argued that the idea of 'the common good' provides a stronger, more robust anchor for collective action than that of the public good. I sought to counter the critique of 'the tragedy of the commons' with that of 'the tragedy of the anti-commons', which brings attention to the cognitive and distributive justice costs of knowledge enclosures in particular. Finally, I articulated the notion of 'commoning' as an emergent approach to building common goods.

The notion of the common good does not, in this argument, advocate a socialist system of activity, where equality is mediated and *homogenised*. Instead, it brings focus to those commoning activities which reinstate relational interaction between possibly diverse and disparate individuals and social groups. It is a shared 'matter of concern' (Latour, 2004) - a shared commons that requires co-learning or co-governance, and therefore, collaboration, which brings diverse parties together. It is a strategy that advocates collaboration in the context of diversity - what could be described as an approach to radical democracy, rather than seeking to homogenise any realm of social being.

The vantage offered by adopting a 'common good' perspective which is realised and enacted through commoning provides particular ontological and epistemic opportunities through which to consider the epistemic cultures of citizen science projects. It begins the work of responding to the opening questions about epistemic activity at the end of 1.3:

1. What constitutes valid knowledge in the context of embodied social-ecological risk?
2. Who is considered a valid knowledge worker/producer in the context of embodied social-ecological risk?, and,
3. What kinds of epistemic cultures are needed for wider participation in knowledge production activities in response to contemporary social-ecological risk?

It does so by firstly reorienting the discussion away from economic and hegemonic rationalities towards openings for considering a wider range of justices and collective goods; secondly, by

foregrounding a relational imperative for collective activity, including epistemic activity; and thirdly, the notion of the common good rearranges what counts as legitimate knowledge and who count as legitimate knowers, expanding this field and extending the bases of legitimation with which we might make value judgements about knowledge. Together these shifts allow me to investigate the epistemic cultures of citizen science projects in terms of their ability to respond to social-ecological risk, rather than in terms of hegemonic contributions to knowledge production and / or capitalist productivity. Citizen scientists are at least given a place at the table, and knowledge production that might not be legitimate within hegemonic systems of rationality are reconsidered in light of their potential contribution to resolving social-ecological risk and co-constituting commons and common goods.

1.6. A Summary of Post-Abyssal Expansions in this Chapter

The diagram below provides a visual summary of the key post-abyssal arguments arising from the sections above.

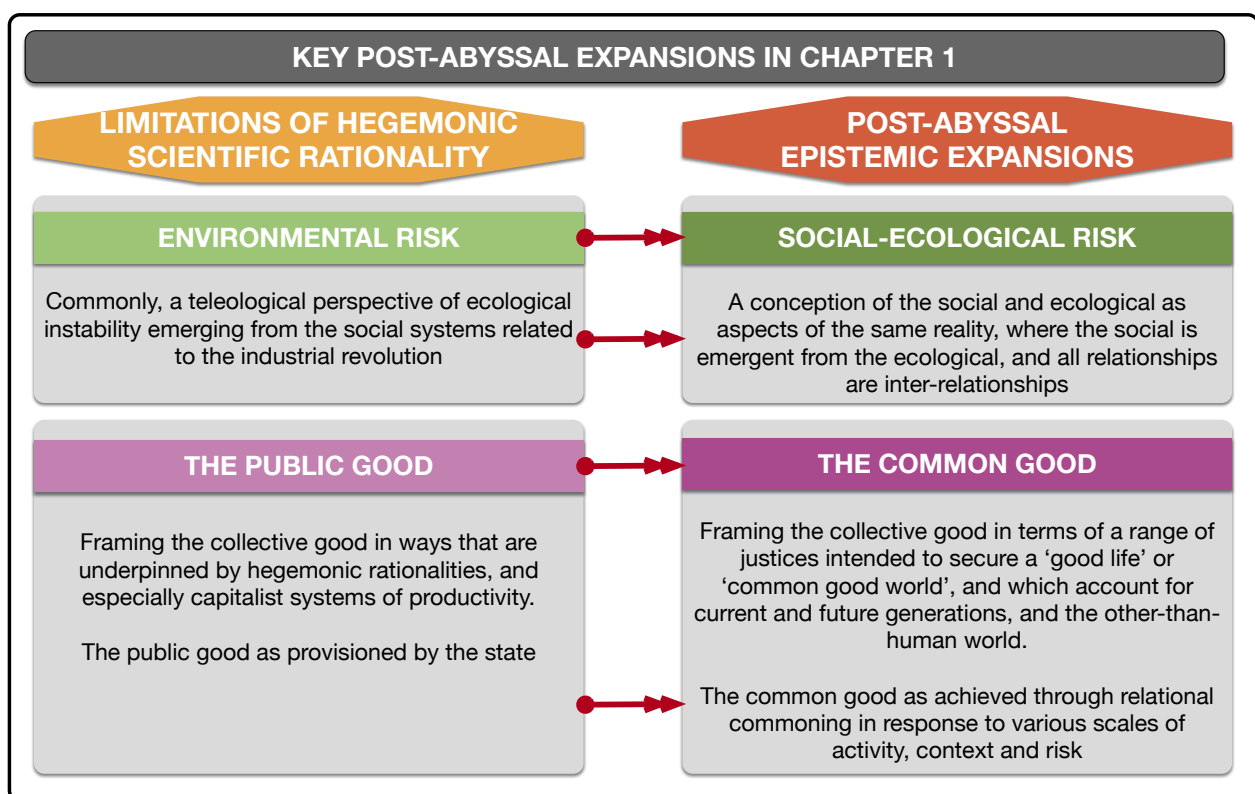


Figure 3: Visual summary of post-abyssal moves in Chapter 1

CHAPTER 2

Towards Articulating Post- Abyssal Epistemic Cultures

2.1. Introduction

My interest in this study is on understanding and strengthening how we co-produce knowledge in response to social-ecological risk. The concept of epistemic cultures is geared towards enabling that investigation. More specifically, viewing the object of interest in the study (that of knowledge co-production for the common good) through the lens of epistemic cultures, enables me to investigate which epistemic outcomes are being encouraged or discouraged within different configurations of citizen science activity. In this chapter, I will provide an orientation to the concept, outlining its theorisation through the work of sociologist Karin Knorr Cetina (2013, 2009, 2007, 1999, 1998), as well as the conceptual contexts within which I take up her framing. The first part of the chapter focuses on articulating a relational conception of epistemic cultures. In the second half of the chapter, I draw on the work of Bruno Latour (2004) and Boaventura de Sousa Santos (2016a, 2004) to further refine and expand the notion of epistemic cultures from a post-abyssal perspective. Latour and Santos, respectively, strengthen a perspective of knowledge production in terms of its ability to intervene into context while strengthening social-ecological justice. Each develops the possibility for robust post-abyssal expansions of knowledge production which centralise the common good.

The description of Cetina's work on epistemic cultures and the expansions enabled through the contributions of Latour and Santos, in turn, provide a basis for examination of knowledge production practices within the hegemonic knowledge systems which underpin views of neoliberal globalisation, and from there lay a foundation for critiques leveraged in Chapter 3.

2.2. Knowledge Cultures as Epistemic Contexts

Cetina begins by describing knowledge cultures as those broader contexts within which particular epistemic cultures are located; they are our general knowledge environments with their attendant structures and policies (Cetina, 2007). Bringing knowledge cultures into view is important because they provide the scaffolding upon which specific epistemic cultures are built (Cetina, 2007). Knowledge cultures are themselves structured to (often normatively) encourage or discourage particular epistemic interests and outcomes. Knowledge cultures work as stabilising fields of normative practice, where previous knowledge work has been validated and is thereby considered 'truth', and the knowledge processes leading to their production 'fall out of view', leaving behind only the 'truths' they produced (Latour, 2004; Cetina, 1998; also see 4.2

for a more detailed presentation of this argument). This process serves to consolidate previous knowledge in a particular field, creating ever-shifting cutting edges from which new knowledge work can be engaged. Knowledge workers working on this edge are not required to re-establish the field, but rather to build on what was previously established as legitimate 'truth'. Because of this normative-making system, such 'established truths' can also become troublesome to interrogate, contradict, or dislodge, further entrenching processes for encouraging or discouraging particular epistemic outcomes or orientations while maintaining the invisibility of the truth-making processes through which they arose (Law, 2004; Cetina, 1998). While the remainder of the thesis is focused on investigating the epistemic cultures within citizen science projects, Chapter 3 is geared towards interrogating the organising principles of the broader knowledge cultures within which citizen science knowledge practices are located.

In Chapter 3, I will critically engage with three key aspects of the general knowledge culture within which the specific epistemic cultures of citizen science projects are embedded. Through these critiques, I aim to surface or make visible the onto-epistemic foundations, beliefs and assumptions inherent within each articulation of knowledge culture, as well as arguing for a range of post-abyssal expansions which potentially strengthen various forms of justice and which increase possibilities for knowledge co-production as commoning in response to social-ecological risks (as argued in 1.5).

2.3. Epistemic Cultures

Epistemic cultures, which are the specific cultures of knowledge production within which epistemic activity is organised, specifically aim to bring the 'truth-making' practices of knowledge work back into view; they bring to bear an interest in *how we know what we know*, rather than a more straightforward focus on *what we know* (Cetina, 2007). Cetina, uses the term epistemic cultures to 'capture these interiorised processes of knowledge creation', and to refer to the 'construction of the machineries of knowledge construction' (2007:363), or ...

those amalgams of arrangements and mechanisms - bonded through affinity, necessity, and historical coincidence - which, in a given field, make up *how we know what we know* (1999:1, emphasis in original).

Epistemic cultures are the cultures of knowledge settings which are composed of specific arrangements of principles and processes that are used in the unfolding and articulation of knowledge (2007), and are diverse in nature.

Cetina argues that understanding the machineries of these knowledge settings matters because it is their construction and functioning which enable or disable particular epistemic outcomes; she points out that they are a structural feature of knowledge societies. Articulating epistemic cultures within their knowledge settings therefore enables us to understand *how and why* particular epistemic outcomes are encouraged or discouraged, and to consider the implications of these choices for the contexts within which they are embedded. In order to do so, Cetina notes that, “one needs to magnify the space of knowledge-in-action, rather than simply observe disciplines or specialities as organising structures” (Cetina, 1999:3). The concept brings into focus ...

the content of different knowledge-oriented lifeworlds, the different meanings of the empirical, specific constructions of the referent (of the objects of knowledge), particular ontologies of instruments, specific models of epistemic subjects (2007:364).

From a social-historical and social-cultural perspective, Holland et al.²⁷, (1998:52) contribute to this the notion of ‘figured worlds’ in which,

a socially and culturally constructed realm of interpretation in which particular characters and actors are recognized, significance is assigned to certain acts, and particular outcomes are valued over others. Each is a simplified world populated by a set of agents ... who engage in a limited range of meaningful acts ... these collective ‘as if’ worlds are sociohistoric, contrived imaginations that mediate behaviour and so ... inform participants’ outlooks.

Refining this further, from a more strongly developmental perspective, Edwards (2005:171), drawing on Vygotsky, points out that,

what is valued in a culture is not only incorporated into the new mental functions but is found in the ways in which the functions are formed, transformed and brought into use. Put simply, minds are shaped by the ways of thinking and concepts in use that are available in particular social worlds and ways of thinking are externalised and revealed in actions.

Such cultures, then, go beyond understanding the simple technical machineries of knowledge production, to an interest in how we go about creating and warranting knowledge within different sets of knowledge practices and socio-cultural histories (Cetina, 2007).

The argument at the foundation of the notion of epistemic cultures is an empirical one, rather than a philosophical one; one which aims to empirically consider the assumption of the unity and universality of science which has dominated since the era of the Vienna Circle, in their work to distinguish between knowledge and culture (Cetina, 2007). Cetina picks up and elaborates on the argument that many authors have forwarded (see for example, Latour, 2004; Santos, 2009; Mignolo, 2000; Haraway, 1989, etc.), that modernist western science is constituted from multiple sciences, which all have specific disciplinary organising principles, ontologies, and systems of

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reference and legitimation. The diverse epistemic cultures within each form of science (and often within disciplines, between specialisms), work to dis-unify the sciences, disrupting the view that there is only one kind of knowledge and one science within the domain of the modernist western sciences, (Cetina, 1999). The notion of epistemic cultures is based on this body of work which explicates dis-unity within the sciences on the basis of their diverse systems for creating and warranting knowledge, rather than through diverse applications of the same set of truth-making principles - said another way, the concept embraces epistemic diversity as the basis of knowledge production in the sciences (Cetina, 2007).

Foundational to this project is an understanding that notions of 'truth' and 'objectivity' are themselves in need of empirical investigation, particularly because they have become "historically and culturally specific 'effects' of ongoing practices and of criteria and beliefs that varied between groups and periods" (Cetina, 2007:363). For example, there is a growing body of research within feminist cultural studies which demonstrate the gendered nature of scientific enquiry empirically and theoretically (see for example Douglas, 2009; Longino, 2002, 1990; Solomon, 2001; Harding, 1991, 1986; Haraway, 1989; Keller & Scharff-Goldhaber, 1987; and Keller, 1982). Kitcher's (2011) arguments regarding science in democratic societies and Lacey's (2005) arguments regarding values and scientific understanding also provide substantive arguments illustrating the cultural effects on scientific knowledge production (also see 2.9 and the critiques in Chapter 3, for more substantive arguments). Not only is knowledge production culturally and contextually influenced, it also has real and tangible political, economic and social effects, and impacts which are neither neutral nor value-free with respect to economic growth, social development or social-ecological impact.

Based on the above, we can identify two key aspects of knowledge cultures which warrant description: a) the relationships between knowledge processes and their referential cultural contexts; and b) between the interiorised descriptions and conceptualisations of knowledge processes and the description of society in knowledge terms. The term 'epistemic culture' also serves to enlarge the sites and spaces of knowledge production beyond disciplinary boundaries or specialisms, and Cetina highlights that although she analyses science, "the notion of epistemic cultures brings into focus the question of knowing in other areas of expertise" (1999:1).

Through the investigation of epistemic cultures, scientists (and other knowledge producers) are brought back into relationship with their multifarious doings, and the multiplicity of contexts, resources, possibilities, and activity systems which they mobilise in the production of distinct forms of knowledge (Cetina, 2007). Knowledge can therefore no longer simply be viewed as the representational and technological product of research, but must also take seriously a view of knowledge which includes its incumbent processes and practices. Therefore, further emphasis within epistemic cultures is on practices, or more specifically, what Cetina terms 'lifeworld processes'. This refinement denotes two important features:

- a) The view that knowledge is referentially connected to the contexts within which it is embedded, and most importantly towards a view of context as embodied, understanding epistemic objects and processes as likewise embodied and giving rise to 'the way meaning is nested in and arises from [their] use' (Cetina, 2007:364); and
- b) An understanding of knowledge as practice and process.

The concept of lifeworlds inextricably relates subjects and objects together, and draws in situated, embodied and relational aspects of context, and in effect brings knowledge production back into a relationship with its social-ecological contexts. It "brings into view broader referential contexts and their temporal, ontological, spatial and other structures" (Cetina, 2007:364). Furthermore, an epistemic culture can serve as a site for a 'nexus of lifeworlds', pointing to an underpinning philosophy of epistemic environments as "merged realms of existence and forms of life" (Cetina, 2007:364).

In summary, the notion of epistemic cultures:

- is based on the idea of epistemic diversity;
- is concerned with the machineries of knowledge production;
- seeks to expose systems of legitimating and warranting knowledge;
- is concerned with which epistemic outcomes are enabled or disabled through its construction; and
- adopts a relational view between knowledge production and context, seeing them as iterative and co-producing.

These features make the notion of epistemic cultures particularly useful for understanding how knowledge is produced and legitimated within the field of citizen science.

2.4. Features of Epistemic Cultures

Cetina (2007) and others (including Edwards, 2011; Maton, 2009; Daniels, 2008; Law, 2004; Latour, 2004; and others engaged below) outline a number of useful features through which we can begin to investigate epistemic cultures. While they are outlined discretely below to support orientation to core aspects, I point the reader to the description above, which stresses the relationality of various aspects within epistemic cultures and their broader knowledge cultures.

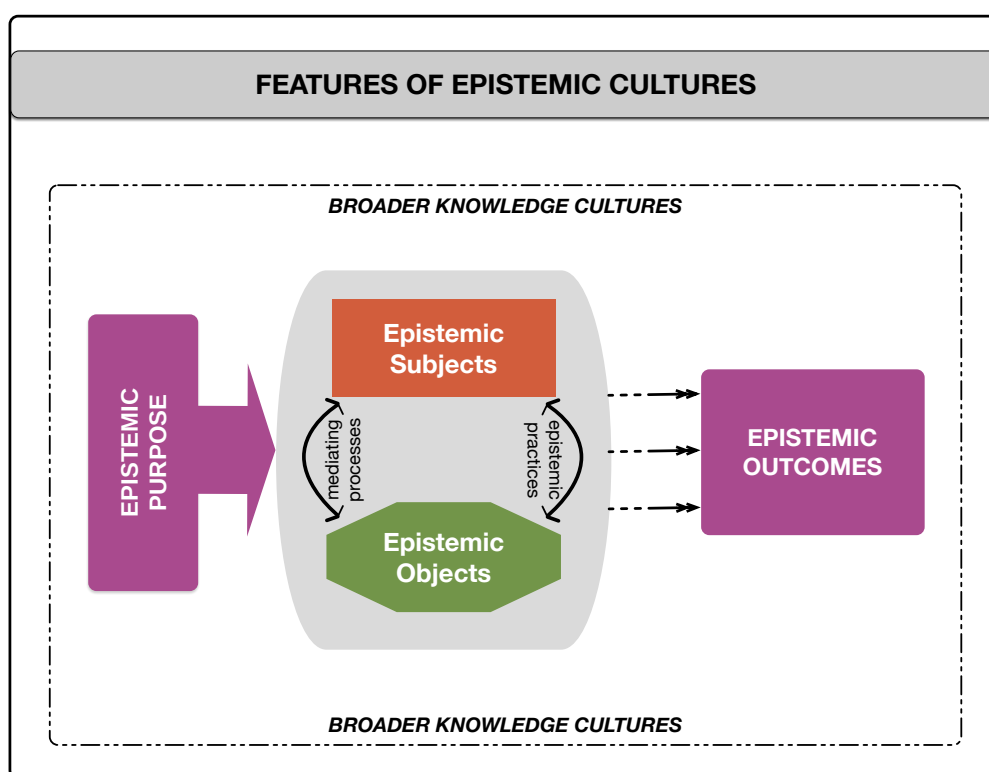


Figure 4: Basic features of epistemic cultures, drawing on Cetina (2007)

Fundamentally, epistemic cultures arise because someone has an epistemic purpose in mind - a need to produce knowledge related to a specific interest. I consider epistemic purposes in more detail in 2.7 and 2.9, primarily drawing on Latour's conception of 'matters of fact' and 'matters of concern' (Latour, 2004). Once an **epistemic purpose** arises, an epistemic culture is assembled, bringing together **subjects** and **objects** into specific epistemic relationships. Their interactions are often facilitated through one or more **epistemic practice(s) or process(es)**, and these interactions result in one or more **epistemic outcome(s)** - hopefully related to the initial epistemic purpose which gave rise to the epistemic culture in the first place.

2.4.1. Epistemic Purposes

Epistemic purposes are those knowledge purposes for which a particular epistemic culture is convened. They describe the intended goals of epistemic activity, and therefore direct, align, and also constrain epistemic activities, objects, relations and the ways in which interactions between these are mediated. Epistemic purposes are generally clearly defined within scientific forms of knowledge work, and generate particular sets of knowledge practices which are geared towards fulfilling them legitimately and verifiably. For example, an epistemic goal to map species data brings within it a range of scientific protocols around sampling techniques, sizes, types of data to be collected, etc. Protocols, as knowledge objects, exert particular epistemic relations between epistemic subjects (how they might interact with the animals being mapped, for example). Data collected within such protocols is considered to be verifiable within the relevant knowledge fields or disciplines.

2.4.2. Epistemic Subjects

Maton (2009:44), expanding on Bernstein's notion of knowledge structures, introduces the concept of *knower* structures. He posits that both knowledge and knowers are specialised, and that combinations of different knowledge and knower structures result in ideas, texts, actors, groups or institutions which partake, some in esoteric, and others in mundane knowledge. Maton suggests that in order to gain a more complete understanding of a knowledge culture, one must consider who the knowers are, and what skills, knowledge and attributes they must have in order to be legitimated within a knowledge culture. He argues that the way in which knowledge structures function result in different specialisations of knowers (*ibid*). The relationship between epistemic subjects and cultures can thus be seen as iterative.

For Cetina (2007), epistemic subjects generally refer to beings that exhibit agency within epistemic cultures²⁸. The notion of epistemic subjects is underpinned by an understanding that how we understand subjectivity, agency, personhood and collectivity varies from culture to culture, and needs to be investigated in real-life, rather than framed theoretically before an investigation into an epistemic culture (Cetina, 2007). Also, epistemic subjects are understood to be constituted of active and passive elements, and they can therefore play both active and passive roles within particular epistemic cultures, and at different times in the same culture.

²⁸ They can also sometimes refer to objects or non-beings who are attributed epistemic agency, although this is not a line of argument I adopt in this thesis.

Subjects can take up a range of epistemic roles and functions (including for example, observer roles, validating roles, representative roles, or in the case of citizen science, scientist or citizen volunteer roles, or in some projects, particular citizen science roles). Roles can be official, acknowledged, unacknowledged or acknowledged only in certain contexts, and also actively absented (Law, 2004). Different roles are often afforded variable status, and with status potentially drawn from roles external to that of a particular epistemic culture (for example, professional scientists might be afforded a higher status than other citizen volunteers, regardless of roles being played within a particular project). In addition, different epistemic subjects may be afforded particular epistemic rights, compared to others within an epistemic community; this could include the right to moderate, validate and legitimate, or to represent knowledge in particular forms or within particular forums.

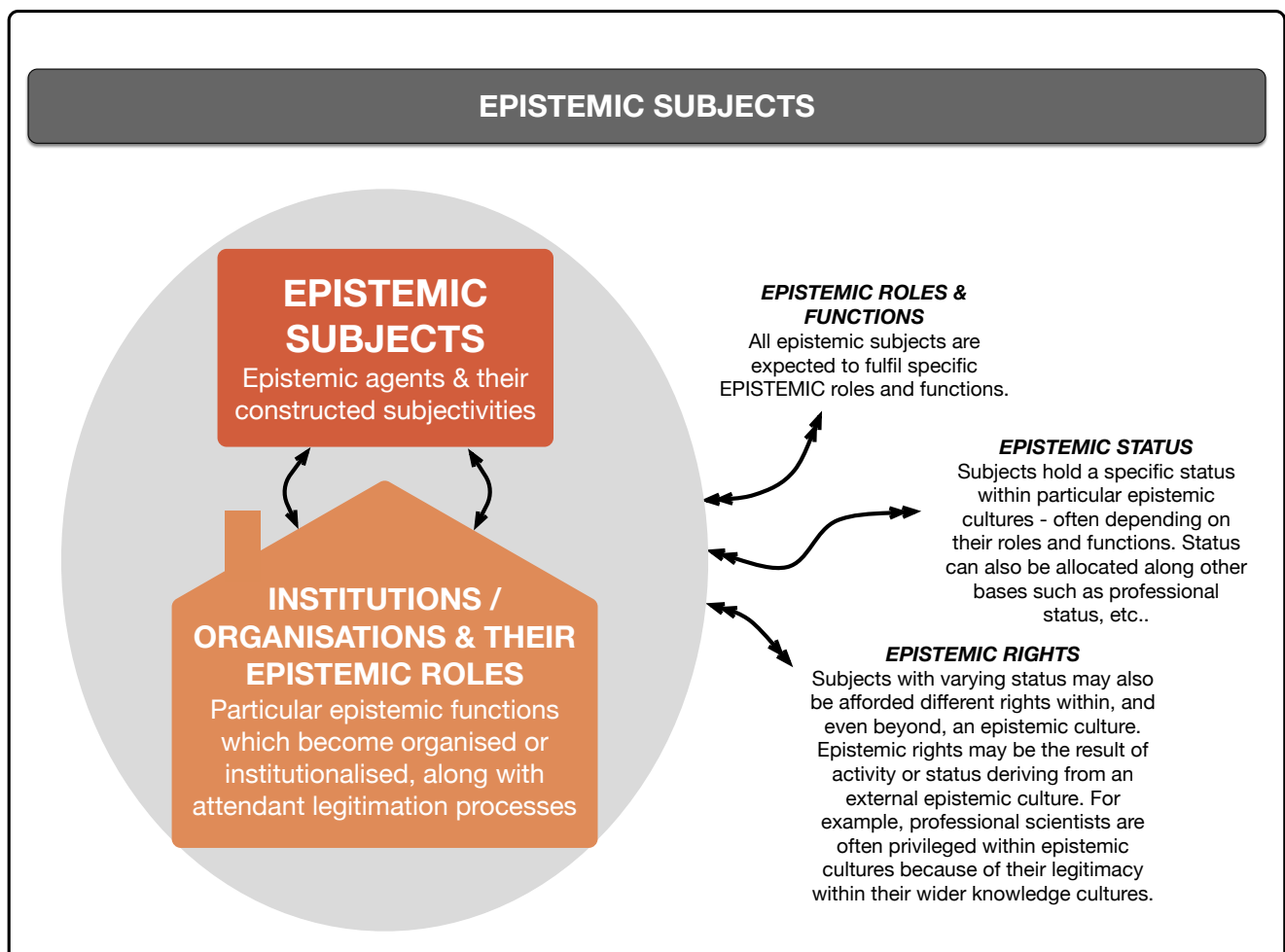


Figure 5: General features of epistemic subjects

2.4.3. Epistemic Subjects and Agency

How agency is conceptualised and conceived is highly contested across a range of research arenas. While conceptions of agency are significant to understanding epistemic cultures, a detailed engagement with agency falls beyond the scope of investigation of the epistemic cultures of citizen science projects in this study. However, the framing of agency, and especially the onto-epistemic implications of how we conceptualise agency are relevant to describing the broader knowledge cultures within which citizen science projects are situated, in addition to how we view epistemic subjects in light of an interest in the common good. Here, I will limit my engagement by delineating a conception of agency that is geared towards considering and enabling commoning activities in response to social-ecological risk, while acknowledging that the topic is more complex than what is represented here. This calls for a perspective of agency that is related to learning which is commensurate with the relational argument of social-ecology framed in Chapter 1. I limit my argument to human agency as my primary interest, although it should be noted that both Cetina (2009, 2007) and Latour (1996) make arguments for object-agency. For the time being, this too falls beyond the macro-analysis of epistemic cultures possible within this thesis.

Many conceptions of agency are geared towards understanding individual agency, which comes with particular onto-epistemic implications, some of which are more closely examined in Chapter 3. In this section, I adopt and forward a relational perspective of agency as more appropriate to knowledge co-production towards the common good. I draw primarily on the work of three sets of authors - sociologists, Mustafa Emirbayer and Ann Mische, Ian Burkitt, and social psychologist, Anne Edwards.

In their review and critique of conceptions of agency, Emirbayer and Mische argue for a conceptualisation of human agency as,

a temporally embedded process of social engagement, informed by the past (in its habitual aspect), but also oriented toward the future (as a capacity to contextualise past habits and future projects within the contingencies of the moment) [where] the structural contexts of action are themselves temporal as well as relational fields—multiple, overlapping *ways of ordering time* toward which social actors can assume different simultaneous agentic orientations (1998:963, emphasis in original).

They describe three analytical dimensions of agentic action as underpinning this definition of agency:

- The *iterational* dimension, which concerns purposeful “selective reactivation of past patterns of thought and action” and which provide a stabilising mechanism for sustaining identities, interactions and institutions over time;
- The *projective* dimension, which includes the generation of imaginative alternative futures and trajectories of action; and
- The *practical-evaluative* dimension, which entails the capacity to make practical and normative judgements between alternative possibilities in relation to an evolving situation (Emirbayer & Mische, 1998:971).

They note that it is possible to distinguish between action that is, “more (or less) engaged with the past, more (or less) directed toward the future, and more (or less) responsive to the present”, and that this shifts in response to an agent’s own understanding of their relationships with past, present and future in relation to their structural contexts (Emirbayer & Mische, 1998:972). Significantly for this study, they argue for the relational and intersubjective nature of agency - one which sees agency as always dialogical, through which actors engage with others within collectively organised contexts of action, and through immersion in temporal passage; the notion of self here is itself dialogical and relational (*ibid*). They argue that, “temporal-relational contexts support particular agentic orientations, which in turn constitute different structuring relationships of actors toward their environments” (Emirbayer & Mische, 1998:1004). Based on their analysis, they forward three propositions, or axes, along which we might investigate agency within empirical research:

Proposition 1: “Actors who face changing situations that demand (or facilitate) the reconstruction of temporal perspectives can expand their capacity for imaginative and/or deliberative response” (*ibid*, 1006)

Proposition 2: “Actors who are positioned at the intersection of multiple temporal-relational contexts can develop greater capacities for creative and critical intervention” (*ibid*, 1007)

Proposition 3: “Actors who feel blocked in encountering problematic situations can actually be pioneers in exploring and reconstructing contexts of action”, premised on the argument that agents capable of switching between agentic orientations might leverage different mediating influences on their contexts of action (*ibid*, 1009).

While Emirbayer and Mische (1998) tend towards a more normative view of agency in relation to structure, rather than the more transgressive arguments forwarded in this thesis as a whole, their foundational conception of agency is nonetheless useful in establishing a relational starting point which foregrounds multiple intersecting temporalities, contexts and forms of agency (or absences thereof). Limitations in their argument include their conception of iteration, which seems more focused on habitual reproduction rather than transgressive reflexivity with the past; here agency can also be seen as iterative through its reflexive relationship with past events or ways of being. Their argument also tends towards privileging a more rational framing of agency (although they do engage briefly with emotive and desirous forms). Additionally, their conception of relational agency is primarily concerned with the relationality of individual agency across time and social context. Here, any collective action is mediated primarily through dialogue between individuals, rather than relationality arising through collaborative effort or in relationship with structure, leaving us with a more narrow field of possibility for commoning activities.

Where Emirbayer and Mische (1998) provide a robust conceptualisation of the internally relational nature of agency, Dépelteau (2008) and Burkitt (2016) engage relationality as pertains to structure and agency. Burkitt grounds his critique on the way in which agency is articulated as individual, and is based on a dualistic relationship with structure (analytically or otherwise). He foregrounds a critique of Giddens (1991, 1984, 1979) and Archer (2013, 2000, 1995), as two of the sociologists whose conceptions of agency have been particularly influential within the humanities (*ibid*). At the heart of his critique is the claim that both Giddens and Archer reify social relations into a third entity (between structure and agency), thereby diminishing the importance of interaction between agents, something Dépelteau (2008:52) argues “limits the potential of sociological imagination”. Burkitt notes that such a view entrenches a western moral and political perspective of agents as independent, autonomous and reflexive individuals. Both Giddens and Archer, Burkitt claims, define agency in terms of an actor’s reflexivity, thereby foregrounding an agential moment of conscious choice in a context where multiple choices are available (*ibid*).

Burkitt’s critique addresses Archer’s conceptualisation most strongly, pointing out that Archer grounds her argument on a notion of ‘analytical dualism’ which preserves the relative autonomy of both structure and agency - each with their own generative mechanisms and causal powers

(*ibid*, also see Dépelteau's, influencing arguments, 2008). For Archer, structures and agents operate in different temporal scales, where structures are the effect of previous activity by agents; agents in turn, are able to address structures through the role of corporate agents who align with others to either conserve or challenge structural systems (*ibid*). At the heart of Burkitt's critique is a recognition that reflexivity stands as the mediator between structure and agency, where reflexivity is purely cognitive and rational - in the mind of an individual agent. The interplay between the substantively different 'universes' of the internal worlds of agents and the external manifestations of structures are then, by needs, mediated through analytical dualism, which attempts to resolve the discrepancies between them (*ibid*; also see 3.2 for a more detailed critique of this form of reasoning). Dépelteau (2008) points out that this means the internal conversation is "a conversation about the society, not within the society" (Dépelteau, 2008:58, emphasis in original). Both Dépelteau (2008) and Burkitt (2016) point out that Archer's analytical dualism prevents a truly intersubjective or dialogical and interactive perspective from arising, because it renders social conversations between people as secondary to the primary internal conversations.

Instead, Burkitt argues for a relational perspective which recognises the manifold social relations within which agents are always situated (2016). Burkitt proposes rather that we view agents,

as interactants, ones who are interdependent, vulnerable, intermittently reflexive, possessors of capacities that can only be practices in joint actions, and capable of sensitive responses to others and to the situations of interaction. Instead of agency resting on the reflexive monitoring of action or the reflexive deliberation on structurally defined choices, agency emerges from our emotional relatedness to others as social relations unfold across time and space (2016:322).

Agency, for Burkitt, is "to do with people producing particular effects in the world and on each other through their relational connections and joint actions, whether or not those effects are reflexively produced" (2016:323). Such a view frames reflexivity rather as an aspect of the relational fabric within which bodily selves are intrinsically embedded. As I will further articulate in 3.2, and as Burkitt argues, it is the analytical-conceptual distinctions on which Archer premises her definitions, which lead to artificial dualisms between things that are ontologically inseparable (Burkitt, 2016). Burkitt points out that structure and agency, and the relationships between agents 'are interrelated from the very beginning', and that such dualistic analysis obscures this in significant ways, even while working to reconcile them post analysis (*ibid*). Burkitt clarifies that relations themselves should be recognised as fluid and ongoing, with varying degrees of endurance as agents enter and exit them at different times; also relations can be transformed both through enacted joint activities and through relations of communication (*ibid*).

Furthermore, “within social formations at any one time there exist different forms of social relations that cannot be reduced to each other or to any one type of social relation” (Burkitt, 2016:331).

Burkitt stresses, again and again, the significance of interdependence in our relationships with each other and with social structures - be they interpersonal relations such as those with family or peer groups, or more impersonal or formal relations such as work, organisations, politics or economics (which have come to be characterised by a division of intrinsically interconnected labour). Burkitt illustrates that it is the nature of our relationships to others, rather than those others as individuals and organisations, which constrain or enable us (*ibid*). This has implications for agency, he argues,

because how we act, the powers we accrue or the constraints upon us, do not rest on our relation to structure but on the nature of our interdependence with others and how this shapes our mutual interactions [...] relations cannot be reduced to ‘shared meanings’ as they involve a range of interdependencies that are physical, meaningful, emotional, practical, economic, political, and social, all of which involve the various things we do for each other - support and constraint, satisfaction or frustration of need, and fulfilling certain roles and functions (2016:331).

Recognising agents as interactants within diverse social situations challenges the theorisation of an unproblematic framing of agency and what is considered agential, and requires us to reconsider notions such as incapacity, patency, necessity, and dependency as part of such framings (*ibid*). Circling back to the concept of reflexivity, Burkitt clarifies that, “while it forms an essential capacity for interaction alongside other capacities, it is variable, intermittent, and limited, bounded by the network of intentional actions beyond the scope of comprehension”, remembering that our own actions don’t always originate in reflexivity, and nor do the intentions of others we interact with, and what is latent, implicit or suppressed also continues to influence how we think and what we do (Burkitt, 2016:335). Agency is constituted within relationships as they unfold across time and space, and also,

cannot be reduced to any specific situation in which these relations unfold because each interactant has a personal biography that cuts across and intersects the manifold relations at different times and places. Also, agency cannot be defined solely by reflexive thought and action because reflexivity is not continuous and constant [...] a relational ontology must begin to contemplate the full complexity of agency whereby this can no longer be conceptualised as an absolute power but has to be understood as a matter of degree. In interrelation, interdependence and interactions with others, interactants are always active and passive, powerful and yet vulnerable to various degrees, acting on others and being acted on by those others (Burkitt, 2016:336).

Burkitt concludes his argument by noting that agency unfolds within the manifold social relations that are sometimes contradictory and ambivalent, and between interactants who are all at once, deeply dialogical, polyphonic, personal and social selves (*ibid*).

From a more 'in-practice' perspective, Anne Edwards (2012, 2005) contributes to these framings of relational agency by conceptualising what it means to take 'action with others'. Her focus is on the enacted aspects of collaborative forms of relational agency, and the potential for collective learning and common knowledge that emerges; her work brings focus to what she describes as the "middle layer of analysis between the system and the individual" (Edwards, 2012:22). Edwards' work moves beyond a dialogical conceptualisation of collaborative work (Emirbayer & Mische, 1889; Mercer, 2000), towards an account that is concerned with the purposes and conditions of joint action (Edwards, 2005). Simply stated, for Edwards, relational agency is "a capacity to align one's thought and actions with those of others in order to interpret problems of practice and to respond to those interpretations" - even more simply, it is 'action with others' (Edwards 2005:169). Importantly, the focus here is on resources outside of the individual mind; it recognises the cultural and representational tools which are able to enhance action. I should point out that relational agency, in this case, is not intended to supplant conceptions of individual agency - instead it identifies a form of agency that arises relationally between people. Edwards also argues that the concept shifts the focus from the system to collaborative action, and the impacts of such action on those who engage in it both between and across systems; in doing so, she claims, it regains a focus on individual and collaborative learning (Edwards, 2005).

Underpinning the concept of relational agency are two others: relational expertise and common knowledge (Edwards, 2012; 2011). These two contribute to social exchange across social boundaries, where boundaries are seen as spaces in which "different practices are brought together to expand interpretations of multifaceted tasks, and not as barriers between the knowledge and motives" of those with different forms of expertise (Edwards, 2011:34); they serve to mediate relational agency.

Relational expertise, for Edwards (2011:33) is, "based on confident engagement with the knowledge that underpins one's own specialist practice, as well as a capacity to recognise and respond to what others might offer in local systems of distributed expertise". This form of

expertise emerges around a 'shared object of activity' - and involves a form of "capacity for working with others to strengthen purposeful responses to complex problems" (Edwards, 2011:33). Relational expertise comprises two parts: a) being able to work collaboratively to expand a shared object of activity through recognising both the motives and the resources that others bring to bear on the shared object, while they simultaneously do the same; and b) re-aligning one's responses to the emerging, evolving and enhanced interpretations, while in the company of others who are engaging in similar activities, and while collaboratively acting on what is now an expanded and expanding object. It requires deliberately engaging with the purposes and practices of others with the intention of enabling collaboration (Edwards, 2011). Edwards is careful to distinguish between specialist knowledge and relational expertise, and draws our attention to the important difference between "the ability to recognise and work with what matters for others" compared to "being able to do what they do" (Edwards, 2011:34).

Collins (2004) also provides a more nuanced engagement here, distinguishing between 'contributory' and 'interactional' expertise, where contributory expertise enables an agent to contribute in legitimated and substantive ways to a professional body of practice, and interactional expertise allows an agent to interact with some level of conceptual competence in a practice, but not be able to contribute to that practice per se (also see Evans, 2008). Collins' distinction is particularly interesting in the context of citizen science, where volunteers (who might have some level of interactional expertise), are called on to make a legitimated knowledge contribution to a particular scientific field. Edwards (2012) explicitly distinguishes between Collins' (2004) and Evans' (2008) framings of expertise, and relational expertise, stressing the significance of mutual value and exchange, rather than being able to interact either within one or another domain of expertise.

Underneath this, common knowledge is comprised of the collective motives and practices of those involved, whether they are in tension with each other or not (Edwards, 2012). It underpins the exercise of relational expertise and serves to mediate relational agency in 'the heat of practice' (Edwards, 2012, 2011). Common knowledge provides both a platform of shared understanding, and a collective resource for further work together (Edwards, 2012). Underpinning Edwards' conception of common knowledge is what Benhabib (1992) terms 'open-ended moral conversations' - a concept that describes a process of commoning within democratic contexts. Benhabib's concept is geared towards a willingness to seek understanding

with another and from there to determine a mutually negotiated path forward, rather than aimed towards consensus-seeking. It is a concept that embraces difference, without aiming to reduce it to a single stance or perspective (*ibid*). Carlile (2004:557) highlights that the “capacity of common knowledge to represent the differences and dependencies now of consequence and the ability of the actors involved to use it” is significant to make knowledge useable. Edwards (2011) adds that because such conversations are based on possibly never knowing the backgrounds of particular moral stances, the acknowledgement of differences can in fact render them generative. She also argues that building common knowledge which enables quick transfer or is easily translatable is important for contexts that require quick and responsive relational work, where “[t]he knowledge of what matters, consequently held in common, is then able to mediate action” (Edwards, 2012:26).

Significantly, the concepts of *relational expertise*, *common knowledge* and *relational agency*, are underpinned by an ethical imperative which foregrounds mutual wellbeing and the actions and interactions required to bring about opportunities for mutual wellbeing; Edwards (2012) draws on the work of philosopher Charles Taylor (1991) to provide an ethical foundation through which we are able to engage with tensions in practice, and where it is important to resist the temptation to privilege one set of ideas, practices, actions, etc., over another - at least in pre-emptive ways. In this way, it provides strong alignment with the argument promoting the common good in 1.5.

Edwards synthesises a number of features which seem to form the basis of successful collaborative engagement in boundary spaces from her work in children’s services, work which could be considered commoning practices. Those of most relevance to this study are presented below. Edwards (2011:35) suggests that in order to build common knowledge that is both substantive and relational, and which is able to successfully mediate collaboration, collaborators should:

- Clarify the purpose of collective work and be open to alternatives (which includes recognising similar long-term open goals);
- Engage in dialogue which reveals the categories, values and motives of various parties involved;
- Take a pedagogic stance to collaborative work;

- Create and develop better tools for collaboration;
- Develop processes for knowledge sharing and pathways for practice;
- Reflexively learn from practice;
- Purposefully engage with varying, overlapping and disparate temporal scales;
- Engage in conceptual exploration, concept-building and concept-translation; and
- Actively manage boundary spaces.

These processes are 'slow work' (*ibid*) that require careful tending and patience to nurture, rather than being implemented through top-down protocols which eliminate processes for mediated collaborative 'world-building' at the boundaries. In effect, they provide a system of commoning activities (see 1.5.4) which recognise and meditate common knowledge-building between potentially disparate groups or individuals.

Although Edwards (2012, 2011) reflects on professional expertise, one of the central arguments that is developed in this thesis is that expertise extends beyond professional, scientific expertise, and that her conceptual toolkit is valuable for considering relational agency between groups of people leveraging a variety of knowledge forms - this argument will be developed throughout the thesis.

From the arguments above, I draw three particular ways of understanding: 1) Emirbayer and Mische's (1998) for their framing of relational agency as it pertains to the 'internal conversation' and social being within individual agents; 2) Dépelteau (2008) and Burkitt's (2016) robust critiques of co-deterministic and dualistic theories of structure and agency, and their arguments for a relational conceptualisation instead; and finally, 3) Edwards' pragmatic or 'in practice' articulation of how such forms of relational agency can be articulated and facilitated in practice, with particular relevance to commoning, knowledge commons and collaborative learning.

Each of the authors above limit their engagement with structure to social structures - those that arise between agents, even while most of their arguments are socio-material in description and origin. However, as argued in Chapter 1, I take a social-ecological stance in this study - one which sees the social and ecological (or crudely, material) as intrinsically interconnected and co-constituting in various and multiple ways, simultaneously and at different points in time. Therefore any explanations which foreground accounts of social structures outside of their

intrinsic relations require reconsideration - I go some way towards engaging with this in the second half of this chapter, and through the critiques in Chapter 3. Latour (2004, 1993) expands notions of relationality beyond social structures to a relationality which reclaims nature (a more detailed argument is presented in 2.7 below, and 3.2), and Santos (2016a, 2004) and Latour both extend conceptions of relationality into the pluriversal and related epistemic activities (see 2.7 and 2.9).

What I am not arguing for in this section, is either deterministic, co-deterministic nor voluntarist perspectives of agency (Dépelteau, 2008) - nor am I attempting to argue that we conflate structure and agency into each other. Instead, my argument (resonating with the arguments of Dépelteau and Burkitt) is that agents are relationally intermeshed with each other and also with the structures within which they are situated and embodied. As will be argued in 3.2, dualism provides an imprecise account of reality because it assigns each to different universes and enforces different properties and rules on each universe separately. Rather, internal conversations and reflexivity, relations between agents, and social and material structures all arise and interact in the same universe together, and are therefore subject to the same ontological treatments and explanations. What is required, then, is a more rigorous approach to description and explanation of the inter-relationships within individual agents, between agents, and between agents and structures (be they social or material). This is a rear-guard approach because dualism is so ontologically foundational to much of science, and while I have attempted a more consciously rigorous approach, I am not sure I have always been successful.

2.4.4. Epistemic Objects and Mediating Artefacts

Cetina (2007) points out that epistemic cultures revolve around objects of knowledge. Epistemic objects can serve to either hold existing practices in place (for example, scientific protocols which are absolute in nature), facilitate transformation through scaffolded meaning-making (for example, experimental resources which lead a subject through a series of reflective steps, with particular emphasis on making epistemic shifts visible), or actively promote transgressive change (for example, a video depicting graphic cruelty to animals in the hopes of promoting veganism). I draw on Cetina's notion of 'objects' of knowledge and 'non-agents' as holders of powers, producers of effects and shapers that are able to mould perception - especially in terms of the configuration and reconfiguration of the various subjects and objects within epistemic cultures,

and their relationships to each other, to expert systems of knowing, and to the local context (2007). Epistemic objects, she says, “have powers, produce effects, may have their own internal environments, mould perception, and shape” the course of activities within epistemic cultures (*ibid*:365). As with epistemic subjects, objects exhibit both active and passive elements and take up active and/or passive roles within a particular epistemic culture. Scientific knowledge practices enable substitution of partial, modified or representative objects which are distanced from their original environments (see for example, Cetina, 2009; Law, 2004; and Latour, 1999). Significantly however, within an epistemic cultures perspective, it is not enough to note the content of meaning structures of a particular epistemic object (for example, a webform or data sheet, text or symbol) - one must also seriously consider their original contexts, embodied use, as well as the ways in which meaning is nested in, and arises from a particular use (Cetina, 2007). The approach calls for researchers to engage in both material and symbolic features as well as the relationships between them.

Expanding on this, Vygotsky (in Daniels, 2008:7) points to the importance of what he terms psychological tools that act as cultural artefacts which influence behaviour from the outside. These psychological tools a) introduce new functions related to the use of a given tool; and b) replace natural processes of learning with others, in new sequences, durations and intensity. In other words, psychological tools re-create and re-order the structure of learning. Knox and Stevens (as cited in Daniels, 2008:8) emphasise that it is not the tools that are important to Vygotsky in relation to development; rather it is the meaning encoded within them. They note that all semiotic systems are tools embedded in action, and thereby give rise to meaning. The meanings encoded within epistemic objects, for Vygotsky, influence the development of learning.

Cole (1996) describes three useful levels of mediating object or artefact, including: a) primary artefacts, which are directly used in productive activity (such as binoculars or water turbidity tubes for testing water clarity); b) secondary artefacts, which are representations of primary artefacts which include the norms, values and procedures which embody the ways of thinking and acting within a particular practice (for example, scientific protocols, observation tools and online data sheets); and c) tertiary artefacts which present the possibility of an imagined world - in other words their aim is not to replicate culture, but rather to promote cultural tools geared towards re-imagination and re-configuration (for example, meaning-making tools such as critical

reflection tools). Engeström (2007), also working within a cultural-historical approach alongside Edwards (2011) and Cole (1996), points out that the same object or artefact may be used in different ways depending on how a shared object of activity is being interpreted and depending on the epistemic purpose or role assigned to it at a particular moment in time. An object could therefore exhibit features at any of Cole's levels, depending on its epistemic purpose in that moment.

For these reasons, epistemic objects and mediating artefacts are significant in considering both epistemic cultures and the mediation of learning. Epistemic objects themselves also enable and disable particular forms of interaction; they can be seen to shape, drive and delimit the nature of the relationships between epistemic subjects participating in citizen science projects. Here, epistemic objects act as the 'places of knowledge' or spacial-temporal arrangements within which epistemic practices are enacted. They also act as mediators of knowledge, shaping learning activities and processes, and providing the semiotic medium for participation within broader knowledge cultures. In other words, as with epistemic subjects, epistemic objects fulfil particular roles and functions. Epistemic cultures are often convened around 'centring objects' - or objects which work to draw together an epistemic culture around specific epistemic tasks or activities. For example, within citizen science projects, this is most often in the form of data sheets and scientific protocols (be they web-based or print-based).

A final way in which Cetina (2007) works with epistemic objects is through considering 'object-relation regimes'; that is, the ways in which epistemic subjects relate to and approach objects of knowledge within research - often in prescribed and presupposed ways. For example, scientific protocols legitimate particular forms and sequences of activity; similarly theories related to particular research objects necessitate forms of enquiry in order to gain legitimacy. Articulating an epistemic culture requires engagement with how a science understands and enacts empirical inquiry, as well as engagement with strategies used to stabilise and legitimate inquiry.

2.4.5. Epistemic Practices, Processes and Infrastructure

[W]hat is at stake in epistemic cultures is not simply the definition of subjects and objects but their reconfiguration in relation to the natural and social orders as they exist outside expert systems and in relation to each other (Cetina, 2007:366).

Cole's three levels of epistemic artefact or object (1996; also see above) provide a useful framing for thinking about epistemic practices as well, because all epistemic objects serve to mediate particular epistemic practices. We could translate Cole's three levels into their corresponding practices, giving us a) practices geared towards fulfilling a particular concrete task (such as focusing your binoculars), b) practices which are geared towards inducting new-comers into a particular system of thinking and doing; and c) practices, which enable new forms of imaginative activity, which are concerned with a shared object but do not necessarily promote established patterns of activity related to said object - rather they provide avenues towards establishing new forms of activity or towards re-imagining and re-defining the shared object. Qualifying the last, Wartofsky emphasises,

[t]he upshot, however, is that the construction of alternative imaginative perceptual modes, freed from the direct representation of ongoing forms of action, and relatively autonomous in this sense, feeds back into actual praxis, as a representation of possibilities which go beyond present actualities (Wartofsky, 1973: 209, in Edwards, 2011).

Epistemic relationships - Descriptions of epistemic relationships are descriptions of how epistemic subjects interact with other epistemic subjects, and relate through epistemic objects. What is centred are relations around knowledge and knowledge practices. Epistemic relationships need not only be harmonious, cooperative, or collaborative; they may also be confrontational, oppositional, or contradictory. Regardless of their form, they are related epistemically, and therefore significant to understanding specific epistemic cultures.

Epistemic infrastructure - The term 'epistemic infrastructure' describes those organisational structures which govern, mediate and facilitate, as well as control, manage, or gate-keep, particular epistemic arrangements within formalised environments. It includes entrenched practices, epistemic objects, and other structured epistemic aspects.

Epistemic settings - Epistemic settings are those specific settings, including but not limited to particular social and expert professional settings, within which knowledge work is located. Epistemic cultures are both facilitated and confined within such settings, drawing on the cultural systems that such settings maintain.

Epistemic cultures are the cultures of knowledge settings, and these appear to be a structural feature of knowledge societies ... Culture, as I use the term, refers to the aggregate patterns and dynamics that are on display in expert practice and that vary in different settings of expertise (Cetina, 1999:8).

Nor are epistemic practices confined to a particular setting. Instead, practices move between and within epistemic settings, and are translated and mediated in the process (*ibid*). For example, citizen science project resources might be developed within the particular epistemic setting of an institution (a university perhaps), and then be relocated to field offices, NGOs, schools, or community groups. How these practices are designed, and worked within in the university will differ greatly from their enactment by a group of volunteers engaged in monitoring within specific contexts. Epistemic subjects themselves transform from setting to setting, adopting different roles and enacting various cultures as socially or professionally required (*ibid*).

Epistemic scales - Epistemic cultures operate across a range of spatial and temporal scales, often simultaneously. Some scales of activity might be intentionally (or sometimes unintentionally) excluded for a variety of socio-political, material or epistemic reasons. Each scale has particular epistemic implications, and likewise, enables different forms and processes of epistemic activity. Spatial scales include locations of epistemic activity, such as laboratories, research centres, virtual or other forms of networks; while temporal scales include, for example, linear and circular scales.

Conditions of epistemic relevance - part of the epistemic infrastructure within epistemic cultures are systems, agents and even possibly institutions for legitimating and warranting both legitimate epistemic activity and knowledge products arising through such activity. These could include conditions external to a particular epistemic culture (such as peer review systems for journal articles on citizen science, professional bodies certifying qualifications, etc.), or internal systems such as data validation processes and controls, etc. As with each of the above, such conditions also act to activity exclude or absent particular epistemic possibilities. These are specifically focused on knowledge-related tasks within larger knowledge contexts, rather than more generally legitimating processes or agents (Cetina, 2007). I extend this argument substantively in the three critiques presented in Chapter 3, arguing that broader knowledge cultures also significantly condition us to decide whether certain knowledge objects are epistemically relevant or not.

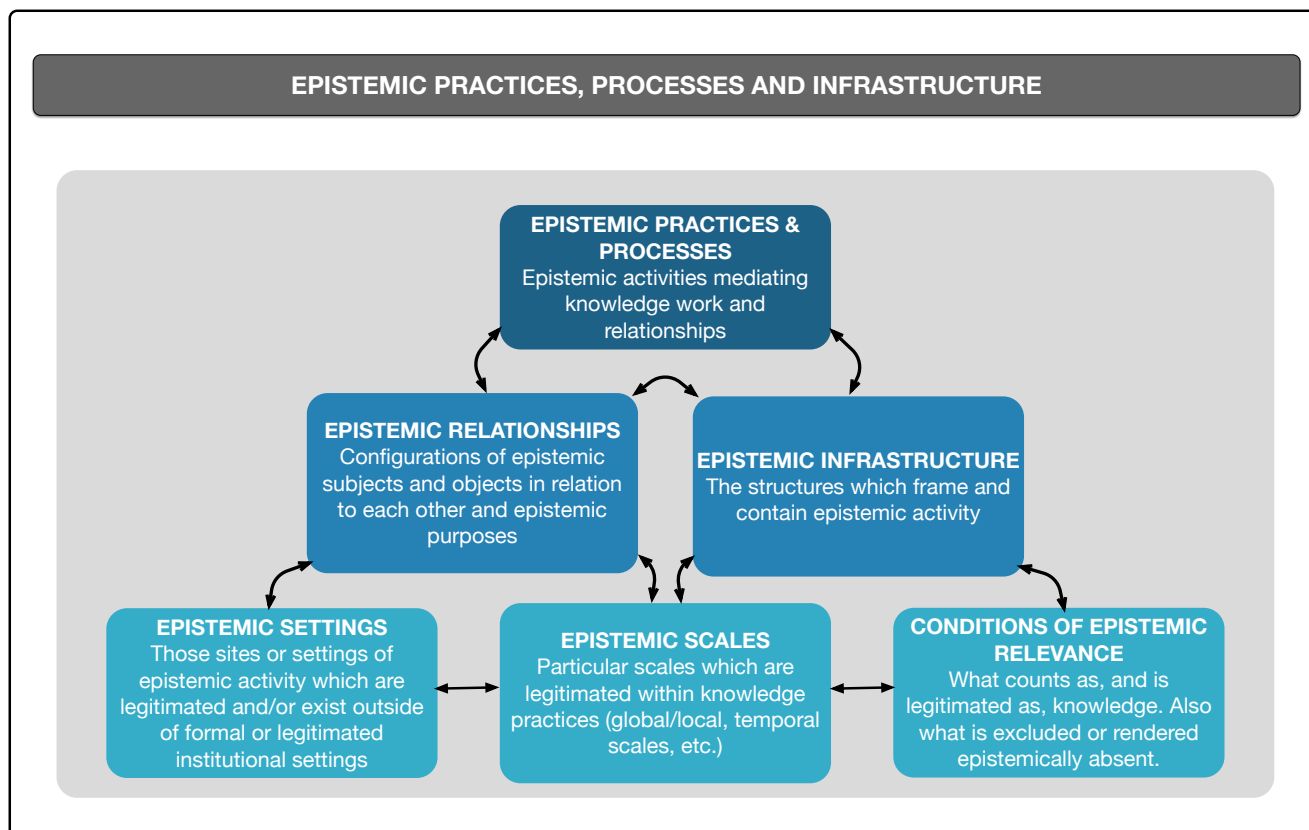


Figure 6: General features of epistemic practices, processes and infrastructure

2.4.6. Epistemic Outcomes

Epistemic outcomes describe both intentional and unintentional knowledge outcomes arising through a particular epistemic culture. Intentional epistemic outcomes are generally aligned with epistemic purposes (the knowledge purposes for which an epistemic culture is convened). They are mediated through official epistemic objects, and arise from often predetermined epistemic relationships and knowledge roles. Cetina (2007:366) refers to these as object-relations regimes which prescribe and presuppose “ways of relating objects of knowledge and of approaching them in research”. Such relations enact practices, protocols and procedures which are geared towards building specific types of knowledge, and meeting the legitimating criteria for such knowledge, either within the disciplinary systems of the sciences, or within specific knowledge contexts (or some combination of the two). Within a citizen science project focused on toad conservation, for example, this might include building geographical mapping data about toad movements, and collecting species counts in seasonal data sets.

Unintentional outcomes include emergent, unofficial or unexpected knowledge outcomes. As will be seen in Chapters 6 and 7, unintentional epistemic outcomes are of particular significance within the epistemic cultures of citizen science projects. These might include forms of

knowledge which are unrecognisable within the legitimating criteria used to evaluate knowledge outcomes; knowledge that is considered un-useful in relation to project epistemic purposes; or previously unthought knowledge offerings. Unintentional knowledge outcomes might remain un-legitimated, or irreconcilable with official epistemic outcomes. Using the toad conservation example again, this might include the development of local innovations to mitigate observed trends in toad deaths, such as the development of micro technologies like swimming pool toad ramps, which remain invisible in their impact in official data records of toad species counts.

2.5. Implications of a Relational Approach to Narrating Epistemic Cultures

I have attempted to argue for the need to consider epistemic activity in relational terms. From such a perspective, it becomes possible to not only recognise that multiple relationships can and do arise between epistemic subjects, and subjects and epistemic objects, but also such relationships are co-constitutive and embroiled. Considering epistemic subjects outside of their relationships with each other, and the epistemic objects, structures or processes through which they are related provides limited analytical categorisations and distinctions between them, and promotes a particular, artificial ontology, which legitimates a hegemonic view of the world and the epistemic cultures within it.

As argued in Chapter 1, the generation and sustenance of common goods arise through relational processes of commoning, and indeed, commoning is a prerequisite for any common good to be enacted authentically. The concept of commoning relies on a relational conception and investigation of epistemic cultures which foreground inter-relationships. As I will argue in the following sections, a relational perspective also enables more just forms of epistemic activity.

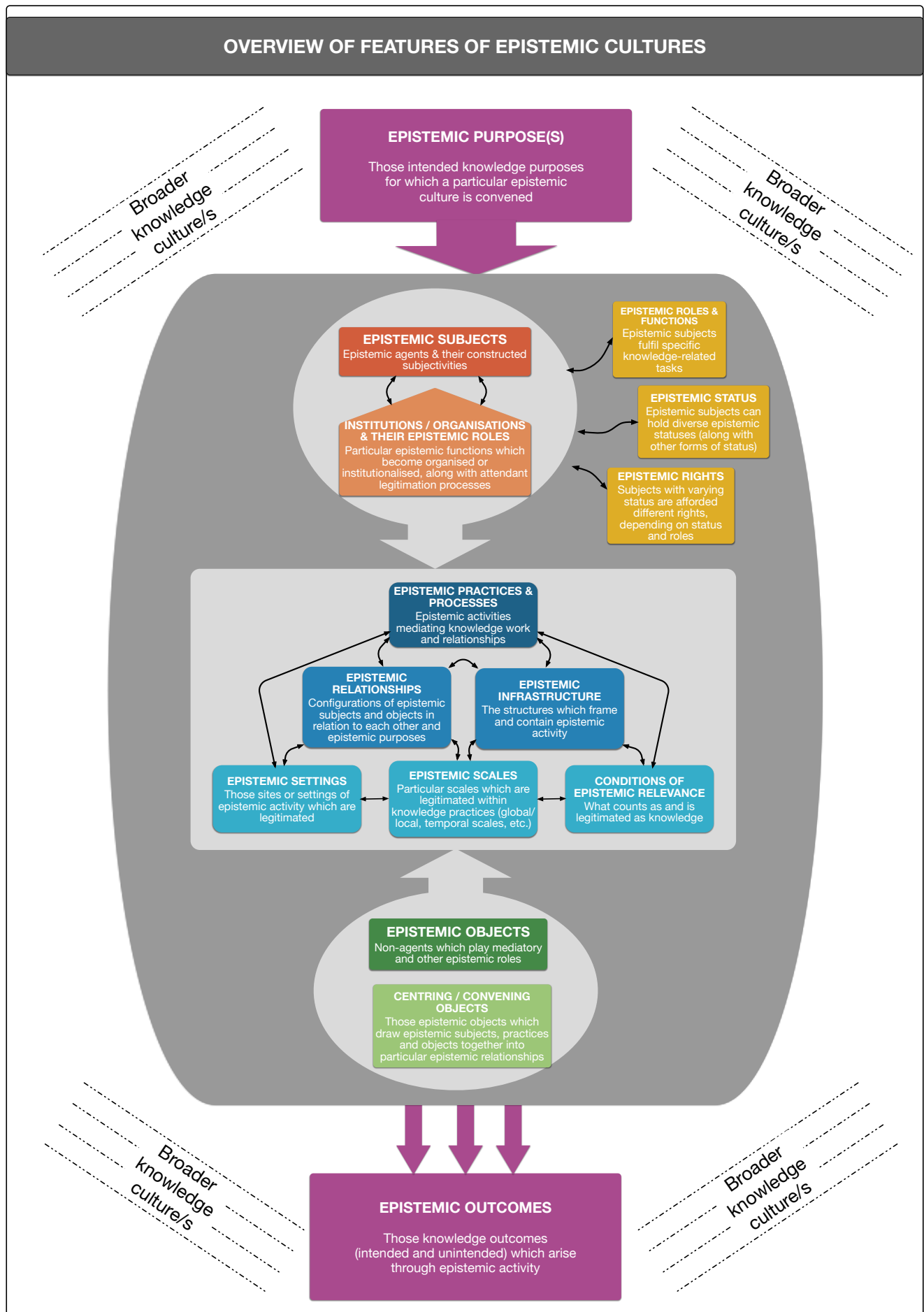


Figure 7: An Overview of Epistemic Features within Epistemic Cultures (Cetina, 2007).

2.6. Deepening Theoretical Conceptions of Epistemic Cultures

Aligning with my interest the epistemic cultures of citizen science projects as potential enactments of social-ecological justice towards the common good, I deepen the theoretical framework provided by Cetina (2009, 2007) by drawing on the work of Bruno Latour (2004) and Boaventura de Sousa Santos (2016b, 2009, 2007, 2004). I draw on these two thinkers to strengthen my theoretical framework with a focus on: 1) how knowledge is currently produced and legitimated in the epistemic activities of citizen science projects, and 2) how we can expand both the processes of knowledge production, and diversify the processes of legitimation in the service of social-ecological justice towards the common good. These expansions enable a more generative re-imagining of the epistemic cultures of citizen science projects.

Both Latour and Santos have a deep interest in knowledge production for the common good, and in relevant usable knowledge underpinned by various forms of justice. Both argue that we need rigours, coherent forms of knowledge which enable intervention into context even amidst increasing contexts of risk and uncertainty; both foreground justice and pluriversality. Latour's work on political ecology offers a critique of knowledge production as a dualistic system which separates out 'nature' from 'politics' (2004, 1993). There is an underlying interest in ecological justice in Latour's work, that makes his critiques particularly pertinent to this thesis. He proposes an alternative to dualistic forms of reasoning which calls for reformulated ways of producing knowledge that are more strongly propositional and accountable in nature. Santos expands the territory of what might be considered knowledge and provides an external critique of scientific knowledge production (2007, 2004). Santos' work resonates with, and expands, what Latour's offers, providing a post-abyssal critique to knowledge production which foregrounds social and epistemic justice - significant concepts when 'thinking' citizen science. I begin by laying out Latour's arguments on re-constituting knowledge production within the sciences, before providing an orientation to Santos' system of sociologies of knowledges. Both theoretical stances are more strongly substantiated in the three critiques provided in Chapter 3. Here I intend to simply lay out an orientation to each theoretical perspective of relevance to this thesis by summarising the arguments offered by each author.

2.7. Bruno Latour's System of Propositions Towards 'Matters of Concern'

In *Politics of Nature*, Latour (2004) argues for a fundamental rethinking of knowledge production within science in response to environmental risk. For Latour, and in resonance with the relational perspective of social-ecology adopted in this study,

the concern for the environment begins at the moment when there is *no more environment*, no zone of reality in which we could casually rid ourselves of the consequences of human political, industrial, and economic life. The historical importance of ecological crisis stems not from a new concern with nature but, on the contrary, from the impossibility of continuing to imagine politics on one side and, on the other, a nature that would serve politics simultaneously as a standard, a foil, a reserve, a resource, and a public dumping ground (2004:58, emphasis in original).

Latour begins his critique by pointing out that some ecological movements have accepted a fundamental flaw which undermines their political interests - the scientific conception of 'nature', and its ontological distinction from 'society'. The outcome of this false and incommensurable modern epistemic distinction is an onto-epistemic distinction between scientific facts and other forms of knowing which are most often subsumed as values, and results in the delegitimisation of other forms of knowing as unprovable, and therefore non-factual and illegitimate in the face of 'objective truth' (2004). This, Latour argues, has far-reaching consequences which work to undermine contemporary abilities to respond coherently to environmental risk. This incoherence and modernist rendering of the world into two distinct domains, he argues, is questionable because each domain is treated differently, while being part of the same world. To overcome this, he argues, we need to revisit the basic assumptions of scientific ways of reasoning (2004, 1993). In Chapter 3, I outline the basis of this argument in more detail, and expand it into three critiques of knowledge production within the sciences, in relation to social-ecological justice. Here, I focus on Latour's articulation of 'matters of fact', propositions, and 'matters of concern' as foundational theoretical contributions to this study.

Latour demonstrates that the modernist scientific process of 'knowing' erects an artificial distinction between facts and values through the practices of science-making which artificially render the world into distinct domains of objective and subjective (2004, 1999; also see Cetina, 2009; Law, 2004). Even more, Latour argues, the coherence of such a knowledge system is threatened when these distinctions begin to blur, because they are ontologically distinct and therefore incommensurable with each other (2004, 1993, also see 3.2). The issue for Latour (2004) is that environmental risk is never about 'nature' or the things 'society' does to nature, but rather about the countless "imbroglios" that emerge through social interactions with and within the Earth System - the relations are embroiled and embedded and so the knowledge we

produce to equip us to respond to such risky “imbroglios” needs to account for and be functional in response to them in their embroiled and embedded states. The field of science studies provides substantive empirical illustration into how the process of science-making is enacted (also see 3.2).

2.7.1. Challenging ‘Matters of Fact’

Latour points out that the artificial ontological distinction between ‘nature’ and ‘society’, and privileging of scientific fact has led to the framing of nature as an object to be investigated, and that,

this nature becomes knowable through the intermediary of the sciences: It has been formed through networks of instruments; it is defined through the interventions of professions, disciplines, and protocols; it is distributed via data bases; it is provided with arguments through the intermediary of learned societies (Latour, 2004:4).

Such rendering into objective fact also permits, legitimises and foregrounds specific relationships with nature, and naturalises these relationships under the guise of fact. He argues that the processes involved in this form of knowledge production disciplines what is known and how it is known in quite specific ways (Cetina, 2009), and that the processes (rendering knowers as objective, and knowledge as value-free) and products (establishment of ‘matters of fact’) are insufficient to the tasks of responding to and resolving modern risk (Latour, 2004). Latour illustrates in detail that the process of establishing ‘matters of fact’ is useful for only specific forms of knowledge-building and has increasingly limited power for intervention within the real world in the context of complex social-ecological risk (*ibid*). As is evidenced in Chapters 5 and 7, Latour’s arguments are relevant to the epistemic cultures of citizen science projects in that it is primarily ‘matters of fact’ which are scientifically reported on, and translated into policy systems, which are then recycled into contexts of risk-response and intervention.

2.7.2. Four Essential Characteristics of ‘Matters of Fact’

Matters of fact are risk-free knowledge objects, and can be identified through four essential characteristics (Latour, 2004:22-23):

1. Such knowledge objects have been produced as having clear boundaries, a well-defined essence, and well-recognised properties. They are defined by strict laws of causality, efficacy, profitability and truth;
2. Researchers, engineers, technicians, and other ‘knowers’ who conceive of and produce such knowledge objects and bring them into the social space become invisible once the object is

finished. All the scientific, technical and industrial activity that goes into the defining and development of such objects remain out of sight - the object stands on its own, and is naturalised;

3. Such knowledge objects are presented as 'risk-free'. Any associated risks, be they expected or unexpected, are conceived of in the form of impact, in a different universe from that in which the fact was constructed. They are consigned to entities indicated by various forms of vague names such as 'social factors', 'political dimensions' or 'irrational aspects';
4. Finally, when any such knowledge objects entail perceivable risks, even catastrophic ones, such outcomes never impact on the initial definition of the object with its attendant boundaries and its essence because they are defined in a universe separate from that which is impacted. In other words, even cataclysmic consequences have no retroactive effects on an objects' responsibilities or its definition, and therefore are unable to serve as lessons to its authors in ways that might lead to modification of the object in question.

Facts force the pluriverse into a singular contorted universe, where everything that does not cohere within such a universe is relegated to a space outside of itself with a different reality and separate rules, broadly encompassed under the notion of values or subjectivity.

In a citizen science project focused on water quality monitoring, for example, this might include the development of water-testing apparatus and protocols which then stand by themselves, separated from the scientists who developed them under very particular circumstances, and with quite specific ideas about how the world works and should work. The apparatus and protocols are recognised as establishing 'truthful' results about the things they test, and any issues with such apparatus might be reduced to user inaccuracies. The social-ecologies of the development of such apparatus fall from view, leaving only a pristine and universally applicable set of scientific tools in view. Any risks that arise through either the use of the tools, or the interpretation, translation and uptake of the data arising from their use fall within the purview of the societies which use them, rather than encompassing the process of scientific production in relation to the societies making use of such fact-based instruments.

2.7.3. From 'Matters of Fact' to Propositions and 'Matters of Concern'

Through the scientific epistemic processes of sterilisation, reification, purification and objectification, objects are rendered as distinct in their own universe, divorced from subjects and

their subjectivity which are made to reside in a separate universe (Latour, 2004; Jones, 2010). To overcome this incoherence, Latour suggests a shift to a system of propositions leveraged to articulate 'matters of concern' (Latour, 2004:247) which would provide greater versatility and usability in addressing risk. The term *proposition* "indicates wonderfully that what is in question is a new and unforeseen association, one that is going to become more complicated and more extended", and enables the shift away from factual statements of certainty, (Latour, 2004:83). Propositions, for Latour, are neither true nor false; instead they hold visible and present what has been assembled in the articulation of a particular matter of concern.

Propositions might be more or less articulated, and plural propositions might be offered to articulate the same matter of concern by diverse spokespersons; they also provide openings for those collectives which might have been silent or silenced to enact greater degrees of freedom and articulation in response to them. They take account of both human and non-human members of the collective which contributed to the definition of a matter of concern, and are articulated with the intention of contributing to the common good world (Latour, 2004). Propositions are neither fixed nor relieved of their responsibilities for better and improved articulation; instead they might be considered a holding space on the cutting edge of knowledge production. As new information and new experiences emerge, propositions are required to take these into account, to reflect on their definition, and to responsively be redefined (recognising that it is the constructors and inventors of such propositions, as well as those who engage such propositions, to whom the task of redefinition must fall, because propositions are not like facts who dismiss their knowers after definition). Propositions then, might better be articulated as 'matters of concern', in contrast to the objective, risk-free 'matters of fact' described above.

Where, with 'matters of fact', the 'facts [appear to] speak for themselves', and are legitimately contestable only through other facts, which can be established by very specific spokespersons most often with scientific skills, propositions tend to be constructed through both the empirical and the ethical, and their validity and relevance is likewise determined through the "imbroglio" within which they are enacted. Who counts as legitimate spokesperson, and what counts as legitimate knowledge are expanded, and the basis of legitimacy shifts to one of relevance to context in relation to the matter at hand (local, national, global, cosmic). 'Matters of concern'

and their constitutive propositions maintain their messiness, riskiness and uncertainty, according to Latour (2004).

In the context of citizen science projects, this might include a more careful re-integration of currently separated epistemic systems of activity, where knowledge is constantly re-made [re-proposed] as common knowledge is being built, used and reconstituted within specific contexts of risk. It would include making both the citizen scientists and legitimated knowers such as scientists and government officials visible within their contexts of power and risk, as well as opening up spaces and legitimated systems of questioning the motives, alignments and powers of legitimated knowledges and knowers, and deepening systems of justice and radical democracy. Section 2.9 continues this work through the articulation of sociologies of absence and emergence, Chapter 3 extends these arguments in terms of general knowledge cultures, and Chapter 7 demonstrates the benefits of doing so in the specific context of the epistemic cultures of three citizen science projects.

2.7.4. Four Essential Characteristics of 'Matters of Concern'

Risky *matters of concern* are distinct to *matters of fact*, and foreground risk, concern and crisis in their definition. *Matters of concern* can be defined (and promoted) by four essential characteristics (Latour, 2004:24):

1. They have no clear boundaries, no well-defined essences or sharp distinctions between them and the rest of their environment. Instead, they adopt the aspects of being entangled, and are rhizomatic or networked or other words that describe their enmeshed natures;
2. Their producers remain visible, responsible and accountable, with all their instruments, laboratories, workshops and factories; their scientific, technological and industrial modes of production remain like-wise visible and held accountable;
3. As quasi-objects, they have no clearly defined impact of their own, they do not arrive as pristine and fully defined. Instead, they might have numerous tentacles, connections, and pseudopods which link them in multiple and diverse ways to other quasi-objects and beings as ill assured as themselves. They consequently no longer constitute another independent universe, distinct from the one in which they are enacted - they are defined and produced in the same world in which they are enacted. To deal with them, Latour notes, "we do not have

the social or political world on one side and the world of objectivity and profitability on the other” (2004:24);

4. Finally, they can no longer be detached from any unexpected consequences they might trigger. Instead, unexpected consequences are expected, and are recognised as belonging to them. They accept responsibility for such consequences, and visibly draw lessons from them which rebound onto their definition, all of which happens in the same universe as the one in which they are enacted.

Working epistemically with ‘matters of concern’ in the context of complex ontological realities makes the mediation of modern science (and knowledge production beyond science) visible, and therefore brings it back into the service of the common good world. ‘Matters of concern’ agitate, trouble and complicate, they provoke speech and, quite likely, controversy (Latour, 2004). As such, Latour (2004) is arguing for epistemic cultures that are not confined to modernist scientific epistemologies, which is an argument of interest to epistemic work enacted through citizen science approaches, as demonstrated in Chapter 7.

2.8. Implications of the Shift from ‘Matters of Fact’ to ‘Matters of Concern’

For Latour²⁹, what is called for is, “the progressive transformation of all ‘matters of facts’ into disputed states of affair, which nothing can limit any longer to the natural world alone - which nothing, precisely, can *naturalize* any longer” (2004:25, emphasis in original). This move shifts us away from certainty about the production of risk-free objects (and their clear distinction between objects and subjects), towards uncertainty about *relations*, and their intended and unintended consequences. It enables the potential emergence of multiplicity that maintains an open-endedness which is usable and informed, but resists definite resolution. More, such redefinition recognises that the sciences are part of the solution towards resolving environmental risk because they are also part of the problem. Part of this is resisting both mononaturalism (one nature) and its consequential multiculturalism (many cultures), both, as being insufficient to the task of coming to know or describe the world because both of these maintain and enforce the division between nature and society. Latour’s influence can be seen in transdisciplinary

²⁹ Latour’s arguments are far more substantive than what is presented here of course. Drawing on Deleuze and Guattari, he articulates a particular system of assemblages between the human and non-human, and extends conceptions of agency to non-human things. These arguments lie outside the scope of this thesis, and should not be read as conceded within this particular study.

approaches to social-ecological sciences through the influence of complexity theorists. As Latour points out,

[t]he solution of mononaturalism stabilizes nature at the risk of emptying the notion of culture of all substance and reducing it to mere representation; the solution of multiculturalism stabilizes the notion of culture at the risk of endangering the universality of nature and reducing it to an illusion (2004:48).

A gift and a power of uncertainty in knowledge production is responsive mobility; where facts are certain and require certainty before mobilisation, concern holds uncertainty fully attendant throughout (Latour, 2004). When dealing with 'matters of concern', certainty is not required before action and response. This is not to imply a lack of rigour in knowledge-building; instead it implies the opposite - a deepening of a broader system of rigour which accounts for empirical and political and many other forms of rigour besides. Propositions maintain their uncertainty publicly - in a way, propositional uncertainty is itself a form of rigour which recognises that all knowledge is obliged to respond to new insights, experiences and changes in the world. This propositional stance which works with 'matters of concern' strengthens and enables opportunities for deeper cognitive and social justice, while in the service of ecological justice. It brings these interests in justice closer together so that they are implicated in each other (even more - embroiled and related to each other) at all levels including at the knowledge production level - just as they are in the lived world.

Another powerful shift is around the accountability of spokespersons for science; where when dealing with facts, the facts 'speak for themselves', with 'matters of concern', spokespersons are obliged to recognise and entertain 'serious but not definite doubts' about both their capacity to speak as well as the knowledge they are offering towards resolution of a particular issue or problem (Latour, 2004). This is particularly significant within the context of citizen science, which include a wider range of knowers across broader epistemic settings (i.e. citizen scientists, professional scientists, government officials across various scales, etc.), and in light of the complexity of epistemic contributions toward common knowledge production. The significance of this is demonstrated through the articulation of epistemic cultures, and especially through the production of sometimes contradictory knowledges by diverse communities of epistemic subjects or knowers (see Chapter 7).

Furthermore, to work with propositions is to actively, a) resist the urge to reduce a matter into a single, simplified, unified perspective, and b) resist reducing or short-circuiting the number and variety of voices (and positions) which seek to contribute to or contest a proposition (Latour, 2004). This raises the question of rigour - how are we to ensure rigour if any may contribute, and unification is resisted? For Latour, this is not about relativism, but rather the ability to intervene into specific contexts of the common good world. His notion of common good world draws together our common world - the Earth System, and making choices in just, democracy-deepening ways - the common good (2004). While Latour does not specifically name particular forms of democracy, his arguments can easily be seen to promote deliberative, participatory and even radical democracy (see 3.3). Latour's view resonates with Santos' own views related to knowledge-legitimacy (2016a, 2004). I make my own contribution towards deepening rigour when working with embroiled systems of knowledge and ecologies of knowledge in Appendix 11.

Perhaps most importantly for this thesis, Latour's arguments (2004, 1993) challenge the notions of modernity which are underpinned by such dualistic reasoning, and provide substantive arguments for rethinking what it means to produce knowledge legitimately. As a segway to the work of Santos and other decolonial, feminist, queer, and counter-hegemonic thinkers, Latour argues for the legitimacy of the pluriverse as a more coherent alternative to scientific dualism. He posits that,

making the mediation of the sciences visible, we can start from nature, not in order to move toward the human element, but - by making a ninety-degree turn - to move *toward the multiplicity of nature*, redistribution by the sciences - something that might be called the *pluriverse* to mark the distinction between the notion of external reality and the properly political work of unification [...] instead of going back and forth between nature and the human, between realism and constructivism, we can now go from the multiplicity *that no collective yet collects*, the pluriverse, to the collective which up to now was gathering that multiplicity under the combined names of politics and nature (Latour, 2004:40, emphasis in original).

The case studies presented in Chapter 7 illustrate the limitations of reducing epistemic accounts and accounting to 'matters of fact', and the generative possibilities for working more strongly with 'matters of concern', as well as the possibilities for increasing commoning and potentially social-ecological justices. While Latour's arguments (as an anthropologist and sociology of science theorist), focus on science, the sciences, and those professionals engaged in such forms of knowledge production (researchers, politicians, economists and moralists, for example), and how one might deepen the rigour and enact systems of commoning between them, his arguments might equally be extended beyond professional acts of knowledge production. It is

at this point that I draw on the work of Santos (2016a, 2016b, 2009, 2004) to provide a counter-hegemonic and post-abysal framing of how such a form of knowledge production might be articulated.

2.9. Santos' Sociologies of Absences and Emergences

Both Santos (2016a, 2016b, 2009, 2007, 2004) and Latour (2004, 1993) critique modernist, mainly western thinking and science as a dominant and preeminent form of unjust hegemonic thinking. Where Latour begins his arguments from a deconstruction of modern scientific practice, and an interest in ecological justice that encompasses social justice, Santos's arguments centralise social and epistemic justices that encompass ecological justice - both work to destabilise the artificial divisions between these forms of justice through reconstituting systems of knowledge production (Santos, 2007, 2004). As outlined in 1.3.1, the notion of cognitive justice calls for a justice between forms of cognition - or forms of cognitive rationality; notions of epistemic justice, on the other hand, are about justice between forms of knowing the world, including cognitive knowledges, embodied and situated knowledges, indigenous knowledges and many other ways of knowing the world. While Santos (2016a, 2016b, 2007, 2004) primarily uses the term 'cognitive justice', I choose to foreground the concept of 'epistemic justice', which seems to more precisely represent the argument he is making. Latour focuses his gaze on the sciences and related systems of knowledge production, where Santos reclaims knowledge for all peoples, with science as only one of a plethora of legitimate knowledge systems.

In his vast body of work, Santos (2016a, 2016b, 2009, 2007, 2006, 2004, among others) argues that modern western thinking is composed of a system of visible and invisible thinking, which become hegemonic through the intersection of capitalist, patriarchal and colonial conquest of western civilisation in many parts of the world. Santos (2016b, 2009, 2007, 2004), argues that the intersecting colonial, patriarchal and capitalist systems provide the base upon which conceptions of knowledge are built. Within the hegemonic system, oppressors and those who benefit from oppressive practices tend to perceive the world in which they live as the best possible world (Santos, 2009). The work of denaturalising oppression involves making visible that besides being unjust, the systems that enact oppression are neither necessary nor irreversible (Santos, 2009).

[Modernist] Scientific knowledge, however supposedly universal, is almost entirely produced in the countries of the developed North and, however presumably neutral, promotes the interests of

these countries and constitutes one of the productive forces of neoliberal globalization. Science is doubly at the service of hegemonic globalization, whether by the way in which it promotes and legitimates it, or by the way in which it discredits, conceals or trivializes counter-hegemonic globalization [...] Discrediting, concealing and trivializing counter-hegemonic globalization go largely hand in hand with discrediting, concealing and trivializing the knowledges that inform counter-hegemonic practices and agents. Faced with rival knowledges, hegemonic scientific knowledge either turns them into raw material (as is the case of indigenous or peasant knowledges about biodiversity) or rejects them on the basis of their falsity or inefficiency in the light of the hegemonic criteria of truth and efficiency (Santos, 2004:13).

Where Latour (1993) talks about the two Great Divides (within science between nature and society, and between modern science and other 'pre-modern' knowledges), Santos articulates the abyssal thinking which arises because of the hegemonic rationality of the West. Santos argues that,

Neoliberal globalization is presided over by technico-scientific knowledge, and owes its hegemony to the credible way in which it discredits all rival knowledges, by suggesting that they are not comparable, as to efficiency and coherence, to the scientificity of the market laws (Santos, 2004:12).

Hegemonic rationality and efficiency thus bring about a contraction of the world by concealing or discrediting all the practices, agents, and knowledges that are not accounted for by their criteria (Santos, 2004:14).

A fundamental premise of abyssal thinking is that modernist science is the only valid and exact form of knowledge, even where much modernist science has failed to deliver viable and just interventions into the world (Santos, 2007). Santos argues that scientific knowledge, as a product of abyssal thinking, cannot be equitably distributed because it was largely politically designed to convert knowledge on one side of the line (science, and to a lesser extent, science's modern others, philosophy and theology) into the subject of knowledge, and all other knowledges into objects of knowledge (Santos, 2009, 2004). Therefore, as evidenced in the world, the real-world interventions that techno-science favours tend to be those which favour and respond to the needs of social groups which have greater access to scientific knowledge and its structural fabrics (Santos, 2007).

Santos argues that while the tensions between the three legitimated forms of knowledge (science, philosophy and theology) are visible, they also take place on the same side of the Abyssal Line in that their visibility is premised on the produced invisibility of other forms of knowledge, such as lay, peasant, indigenous and plebeian (among other) knowledges, which have been relegated to the other side of the line (2007, 2004). Other forms of knowledge, Santos argues,

vanish as relevant or commensurable knowledges because they are beyond truth and falsehood. It is unimaginable to apply to them not only the scientific true/false distinction, but also the

scientifically unascertainable truths of philosophy and theology that constitute all the acceptable knowledge on this side of the line. On the other side of the line, there is no real knowledge; there are beliefs, opinions, intuitive or subjective understandings, which, at the most, may become objects or raw materials for scientific enquiry (Santos, 2007:2).

Rather, Santos demonstrates, other knowledges are actively produced as non-existent, and it is this process of rendering the 'other' as nonexistent that is at the heart of abyssal thinking - it enacts a 'radical denial of co-presence' (2009, 2007). Nonexistence here means not existing in comprehensible or relevant ways to contemporary forms of hegemonic neoliberal globalisation or historical forms of coloniality, patriarchy or capitalist ascendancy. What is produced as nonexistent is actively and radically excluded because it functions in ways which are apparently irreconcilable with hegemonic rationality (Santos, 2007). This is achieved through a trick of hegemony which converts simultaneity into non-contemporaneity - in other words, what is in fact contemporary and simultaneous socially, is converted into an irrational distinction between whiggish modernity (elevated as apparently superior) and other forms of enacting the world (designated as primitive, pre-modern, barbaric, undeveloped, etc.) (Santos, 2007, also see Latour, 1993; Goody, 2006, 1995). Latour's arguments above (and again in 3.2.1.2.) already bring us some way towards reconstituting a more coherent rationality which undermines the rationality underpinning hegemonic neoliberal globalisation, however, his work falls mainly on the scientific side of the Abyssal Line; Santos' work widens this breach even further, working to reclaim the other side of the Abyssal Line.

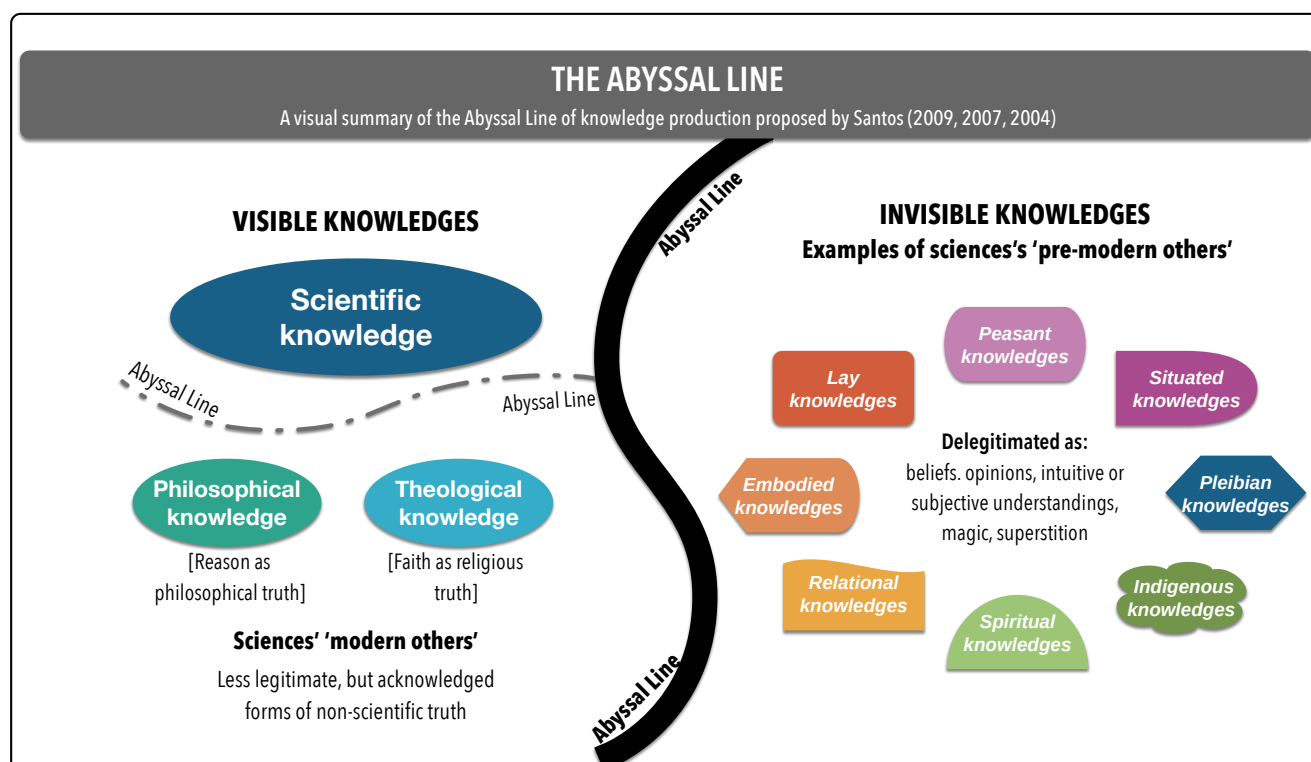


Figure 8: Santos' Abyssal Line (2007, 2004)

2.10. Counter-Hegemonic, Post-Abyssal Thinking

In response to hegemonic neoliberal globalisation, Santos, in the company of many others³⁰, contributed to establishing the World Social Forum (WSF) - a forum convening a wide scope of liberation movements against colonialism, capitalism and patriarchy (including for example, the Afro-descendent civil rights movement, feminism, ecology, indigenous movements, liberation theology, the urban movement, LGBT movements, etc.) (Santos, 2004). Rather than being unified by any particular theoretical, ideological or practice perspective, the WSF convenes around a constitution which embraces diversity and complex, sometimes contradictory, approaches to counter-hegemonic, post-abyssal emancipation. Through their enlargement of the scope of social struggles, Santos points out, each of these movements have generated “new conceptions of life and human dignity, new symbolic universes, new cosmogonies, gnoseologies and even ontologies” (Santos, 2009:112).

Because social exclusion is always the product of unequal power relations, Santos contends, the redistributive ethos animated through and within these initiatives, struggles and movements can be perceived in the broadest sense, and encompasses material, cultural, political, social and symbolic resources. Such an ethos is based on deepening distributive justice, the principle of equity and also the principle of recognition of difference (Santos, 2007). Post-abyssal thinking then, recognises that the diversity of the world is inexhaustible, in spite of an adequate epistemology, and calls for a reclamation of the epistemological diversity premised on epistemic justice (Santos, 2007). Santos’s arguments establish legitimate epistemic ground for the recognition that social-ecological risks manifest diversely, and impact people in a diversity of ways. As evidenced in Chapter 7, this perspective is a key one for considering the epistemic cultures of citizen science projects, in that it opens up the possibility for re-examination and re-imagination of who is producing common knowledge, and why and how they are doing so, while simultaneously recognising that all knowers might be enacting different why’s and how’s concurrently.

Palmer argues that “the way we know has powerful implications for the way we live” and “every mode of knowing contains its own moral trajectory, its own ethical direction and outcomes” (Palmer, 1987:2). Deepening Palmer’s argument which are not that different to Latour’s, a basic

³⁰ Including Oded Grajew, Cándido Grzybowski and Chico Whitaker as well as many individuals, coalitions, NGOs and other global South movements

premise of Santos' critique is that all knowledges have internal and external limits - they render some things visible even as they render others invisible - the 'truths' that they offer are therefore always partial and incomplete. He points out that because no single knowledge is able to fully account for all possible interventions in the world, they are all incomplete and therefore limited in different ways (Santos, 2007). Internal limits relate to those restrictions a knowledge form might impose on real-world interventions, while external limits result from the recognition and acknowledgement of alternative interventions which are made possible through other forms of knowledge (Santos, 2007). Santos points out that the,

finitude of each way of knowing is thus twofold: it is made up of the limits of what it knows about human experience in the world; and the limits (albeit much larger) of what it knows about the world's other ways of knowing, hence about the knowledge of the world supplied by other ways of knowing (Santos, 2009:115).

Hegemonic knowledge forms recognise only internal limits, and rationalise away external limits by rendering them invisible. An exploration of both the internal and external limits of modern science as practiced by Latour (2004) can therefore only be achieved as part of a counter-hegemonic or post-abyssal re-conception of science which does not restrict the use of such science to science alone - instead science must be convened into an ecology of knowledges (Santos, 2007). Santos notes that, simply because we recognise that it is not possible to reach the 'truth' with accuracy within our epistemic activities, does not release us of the responsibility for searching for it - it calls for a form of "learned ignorance" which instead entails the rigorous work of reflection and interpretation of the limits of our search for such truth, and of the possibilities they generate and the exigencies they enable (Santos, 2009). In light of this, as Santos points out, global social justice (and I would add social-ecological justice) is impossible without global epistemic justice (2007, 2004).

Post-abyssal forms of knowledge production call for 'an alternative thinking of alternatives', for radical co-presence, where co-presence is taken to mean that practices and agents on both sides of the Abyssal Line are recognised and accepted as contemporary in equal terms, (Santos, 2007). Such forms of thinking are non-derivative and involve a radical break with dominant modern scientific ways of thinking and doing; it requires learning to think from the perspective of the other side of the Abyssal Line, precisely because the other side of the Abyss has been rendered 'unthinkable' in hegemonic western modernity (Santos, 2007). This form of thinking confronts the monoculture of modern science, and its related systems of activity, with ecologies of knowledges which recognise and embrace the plurality of heterogenous knowledges

(including the modern sciences in their number), recognising the dynamic interconnections between them without undermining their autonomy - here knowledge is recognised as inter-knowledge (2007). Nor do such post-abysal ways of producing knowledge imply discrediting scientific knowledge; instead the aim is the post-abysal expansion of science, which ensures the credible inclusion of other forms of knowledge. This process includes an exploration of the internal plurality of science as argued by Cetina (2007) and Latour (2004) above, as well as those alternatives which have been made visible through the contributions of feminist, post-colonial, and other counter-hegemonic epistemologies. Such a process also promotes the interdependence and interactions between scientific and other forms of knowledges (Santos, 2007). This post-abysal expansion enables an account of citizen science epistemic activity which intentionally reclaims and makes visible, those forms of knowledge which are systematically excluded by modernist scientific knowledge generation, while simultaneously including scientific knowledges in common knowledge production in response to social-ecological risks. Chapter 7 demonstrates the advantages of such an approach.

Central to this reformulation of knowledge work is the recognition that all forms of knowledge constitute subjects and uphold practices. All knowledges testify what they know of reality (what Santos identifies as their active dimension) through what they reveal about the subject of such knowledge (subjective dimension, for Santos 2007). Although complexity sciences question the distinction between subject and object, they do so only in relation to scientific practices. Santos' sociologies expand this work to encompass the relations between scientific and other forms of knowledge, and thereby expand the range of inter-subjectivity as the correlate of inter-knowledge (Santos, 2007). Post-abysal thinking is premised on the recognition of an epistemologically diverse world beyond what is recognisable within modernist scientific knowledge; this delegitimises any single general epistemology, and calls for those processes of knowledge production which enable and facilitate the production of inter-knowledge (Santos, 2007). Santos (2009:111) challenges us to work with existing epistemic practices and theories in three ways,

first, to show that the theories and disciplines lose their composure and serenity when they are challenged by questions, no matter how simple, which they did not ask themselves; second, to identify complementarities and complicity where the theories and disciplines see rivalries and contradictions; third, to show that the efficaciousness of theories and disciplines lies as much in what they show as in what they conceal, as much in the reality they produce as existent, as in the reality they produce as nonexistent.

Again, in resonance with Latour (2004), the ability to work in contexts of uncertainty, towards a common good life is centralised, and the power to intervene into contexts is privileged as a basis of legitimation. Therefore, for ecologies of knowledges,

knowledge-as-intervention-in-reality is the measure of realism, not knowledge-as-a-representation-of-reality. The credibility of cognitive construction is measured by the type of intervention in the world that it affords or prevents (Santos, 2007:13).

Santos, like Latour, calls for us to embrace radical uncertainty about a better future and its attendant risks. Santos privileges those ways of knowing which enable actions focused on the everyday, and which amount to tangible improvements in the here and now, most especially in the lives of the oppressed and excluded (2009). This is a key epistemic benefit for evaluating knowledge contributions within the epistemic cultures of citizen science projects because it refocuses the basis of legitimation to the contexts of risk in which common knowledges are being produced, and to which they respond. It reconstitutes the bases of legitimation for valid knowledge contributions towards their ability to intervene into such contexts of situated, and locally articulated risks.

2.11. Sociologies of Absences and Emergences as Post-Abyssal Thinking

Santos offers us the sociologies of absences and emergences as a form of post-abyssal thinking. The sociologies of absences and emergences are sociologies,

built against hegemonic social sciences and upon alternative epistemological presuppositions ... Through the sociology of absences and the sociology of emergences, social experience that resists destruction is unconcealed, and the space-time capable of identifying and rendering credible new counter-hegemonic social experiences is opened up (Santos, 2004:14).

Santos' sociologies include three key elements: a) modes of produced non-existence, b) sociologies of absences which seek to counter produced non-existence, and c) sociologies of emergence, which seek to recognise and make use of knowledge generated through ecologies of knowledges. Each of these is engaged within this study, and therefore described in more detail below. Figure 9 summarises these elements.

2.11.1. Logics or Modes of Nonexistence

The sociology of absence begins with the recognition that what does not exist within hegemonic rationality is in fact activity produced as non-existent, and actively rendered as a non-credible alternative to what is legitimated within hegemonic knowledge, as represented by mainstream science. Santos argues that there is no single way of not existing, and that the logics

and processes through which hegemonic rationality and efficiency produce non-existence are diverse; nonexistence, he points out, is produced “whenever a certain entity is disqualified and rendered invisible, unintelligible, or irreversibly discardable” (Santos, 2004:15). The empirical object of any alternative is deemed impossible in light of conventional science; therefore the formulation of such objects represent a break with scientific conventions and the work of the sociology of absences is to transform impossible into possible, non-credible into credible, and absent into present objects (Santos, 2004). Santos identifies five dominant logics or modes of production of non-existence (Santos, 2007, 2004):

a. *Monoculture of knowledge and rigour of knowledge*

Here, modern science and western notions of high culture are positioned as the sole criteria of truth and aesthetic quality, respectively. In terms of this logic, nonexistence is framed as ignorance or lack of culture (this is argued more substantively in 2.11.2.a).

b. *Monoculture of linear time*

Within this logic sits the conception that history has a well-known, unique meaning and direction - an anachronistic or Whig account of history (Mayr, 1990; Wilson & Ashplant, 1988; Butterfield, 1965), which is based on conceptions of scientific advance and reification of neoliberal utopian ideals. Nonexistence is produced by describing as backward (underdeveloped, primitive, premodern, savage, barbaric, traditional, the obsolete, the simple, etc.) whatever is asymmetrical to those things identified as forward (modernist techno-scientific development, the high culture of the West, neoliberal democracy, etc.). Western modernity renders what is contemporary and simultaneous, non-contemporary. Nonexistence assumes the form of residuum or left-overs from a more primitive and barbaric past (also see 2.11.2.b).

c. *Monoculture of naturalisation of differences*

This logic of production foregrounds the distribution of populations according to groupings which naturalise hierarchies (most prominently, racial and sexual classifications, among others). Santos (2004) highlights that social classifications are based on attributes which negate the intentionality of such hierarchies, and domination is the consequence, rather than cause of such hierarchies. Here, nonexistence is produced as forms of inferiority which are insuperable because of their naturalness; those deemed as inferior, because of their apparently

insurmountable inferiority, cannot or are not seen to be credible alternatives to superior ones. (Also see 2.11.2.c and 3.2).

d. *Monoculture of the universal and the global*

Conceptions of dominant scale are centred through this logic. Within western modernity, this assumes two forms: the universal and the global. Universalism encompasses the realities that are seen to prevail regardless of specific contexts, and for that reason are rationalised to take precedence over all other context-specific realities which are considered particular or vernacular. Globalisation privileges realities that widen their scope to the whole globe, thereby earning the authority to designate rival entities as local. Within this logic, nonexistence is produced in the forms of the particular and the local, where realities or entities defined as particular or local are framed in scales that render them as being incapable of being credible alternatives to those entities or realities framed as universal or global (also see 2.11.2.d).

e. *Monoculture of the criteria of capitalist productivity and efficiency*

This logic of nonexistence privileges growth through capitalist market forces, and encompasses both human labour and nature. Here, maximising productivity within productive cycles, and maximising profits in the form of capital are elevated. Nonexistence is produced in the form of nonproductiveness as sterility or self-sustaining productivity without surplus available for market exploitation in nature; and in relation to humans, as professional disqualification, lacking skills, discardable populations, laziness, etc. (also see 2.11.2.e)

Santos summarises that there are thus,

five principal forms of nonexistence produced by hegemonic epistemology and rationality: the ignorant, the residual, the inferior, the local, and the nonproductive. They are social forms of nonexistence because the realities to which they give shape are present only as obstacles vis-à-vis the realities deemed relevant, be they scientific, advanced, superior, global, or produced realities. [...] They are what exists under irretrievably disqualified forms of existing (Santos, 2004:17).

Chapter 3 is dedicated to explicating produced non-existence through three interrogations of the general knowledge cultures within which citizen science is enacted, and in relation to social-ecological justice towards the common good - more detailed arguments of produced non-existence are reserved for that chapter.

2.11.2. Sociology of Absences

In response to the modes of produced non-existence, the *sociology of absence* creates conditions which intentionally expand the field of experience, both in the current context, and also in terms of increased possibilities for social experimentation in the future (Santos, 2007, 2004). It does so by transgressively confronting each of the identified modes of produced non-existence or absence through practices of transformative knowledge and transformative action (Santos, 2004). In other words, “the sociology of absences is the sociology of absent ways of knowing, that is to say, the act of identifying the ways of knowing which the hegemonic epistemology produces as nonexistent” (Santos, 2009:115). Taking the stance that the social production of these modes of nonexistence and, therefore absences, results in wasted social experience, the sociology of absences aims to identify wasted social experience, which has been produced as absent, in order to liberate them from the relations of absent-making-production, and thereby make them present and credible (Santos, 2004). For Santos, to be made present “means to be considered alternatives to hegemonic experience, to have their credibility discussed and argued for and their relations taken as object of political dispute” (Santos, 2004:17). To achieve this in practice, the sociology of absences replaces monocultures of production with ecologies. The term ecology describes “the practice of assembling diversity by way of identifying and promoting sustainable interactions among heterogenous partial entities” (Santos, 2004:18). There are five ecologies in response to the five modes of produced non-existence, including the ecologies of knowledges, temporalities, recognitions, trans-scales, and productivities. I focus on the ecology of knowledges as central to this study, with only brief descriptions of the other four ecologies, as relevant.

a. Ecology of knowledges

This first ecology aims to confront the monoculture of modernist scientific knowledge and rigour, and the epistemicides which are their outcomes, through the identification of other knowledges and criteria of rigour which operate credibly in social practices. Such ecologies aim,

to create a new sort of relationship between scientific knowledge and other kinds of knowledge. It consists in granting “equality of opportunities” to the different kinds of knowledge engaged in ever broader epistemological disputes aimed at maximizing their respective contributions to build “another possible world”, that is to say, a more democratic and just society, as well as a more balanced society vis-à-vis nature (Santos, 2004:19).

It aims to provide epistemological (or more accurately, gnosiological³¹) consistency for pluralistic, propositional thinking, and is a destabilising epistemology in that it engages in a radical critique of the politics of the possible, without succumbing to the politics of produced non-existence (Santos, 2007). Here, knowledge is not conceived of in abstraction, but rather as knowledge practices and those interventions which they enable or impede in the real world (Santos, 2007).

Each knowledge contributes the way in which it leads and mobilises knowledge practices to overcome certain ignorances, therefore, dialogue and confrontation among knowledges, is “confrontation and dialogue among the different processes through which practices that are ignorant in different ways turn into practices that are knowledgeable in different ways” (Santos, 2004:19). This elevates the importance of comparing knowledge that is being learnt with those knowledges being unlearned, forgotten or absented through the knowledge practices being engaged in a particular ecology (Santos, 2007), which offers space for reframing and (re)stor(y)ing the epistemic cultures of citizen science projects with social-ecological justice in mind.

What Santos describes as *epistemological pragmatics* is justified on the basis of the life experiences of the oppressed and is made intelligible through an epistemology of consequences for the oppressed who typically experience consequences first, and causes second (Santos, 2007). Therefore, the epistemological dimension of the ecology of knowledges is a form of solidarity among social actors engaging in social-ecological justice work. Such a solidarity is internally diverse and embraces the multiple, possibly autonomous, positions from which each chooses to engage - inter-knowledge is mobilised towards inter-movements which are enabled towards collective actions in response to risk and injustice (Santos, 2009). Ecologies of knowledges privilege the ability to intervene into context while foregrounding an

31 It is useful to distinguish three terms in relation to each other at this point: doxa, gnosiology, and epistemology. My understanding is that where doxa describes opinions and beliefs, gnosiology is the philosophy of knowledge and inquiry into the basis, nature, validity and limits of knowledge. It includes perceptual knowledge, and metaphysical dimensions of knowledge, etc. Epistemology, in contrast, is the theory of systematic forms of scientific knowledge. Although it would be more accurate to talk of gnosiology instead of epistemology within the context of this thesis, use of the term gnosiology has diminished to such an extent that it might prove unrecognisable to many readers. Additionally, the term epistemology has taken on an expanded use that references knowledge production for many counter-hegemonic and post-abysal researchers including Santos and Mignolo. To facilitate easier reading, it is in this second form that I use the term ‘epistemology’. Here, epistemology is taken to mean ‘how we come to know the world’, encompassing all forms of knowledge production, including but not limited to scientific knowledge. (This understanding was synthesised through reading a number of philosophy discussion forums, and reading across a range of dictionaries).

emancipatory interest; it therefore centres relationally applied and applicable knowledges 'on the move'. Ecologies of knowledge are established through constant questioning and a recognition of and valuing of incomplete answers - this enables a broader vision of what is known, what is not yet known, and an active mobilisation of learned ignorance within our specific knowledge practices (Santos, 2007). This form of openness and uncertainty resonates well with Latour's propositional approach to engaging with 'matters of concern' (Latour, 2004).

At the specific level, an ecology of knowledges implies the selection of ways of knowing and assembling a field of interaction towards a particular contextual challenge (while attending to the other ecologies described below, including trans-scales) (Santos, 2009). Contextual credibility is considered a sufficient condition for such knowledges to legitimately participate in epistemological debates with scientific (and other) forms of knowledge. An articulation of ecologies of knowledges convened within three diverse citizen science projects is presented in Chapter 7, and represents the primary ecology worked with in this study. This articulation highlights epistemic, contributory and distributive justice issues as aspects of the social-ecological justice works engaged within those projects. It makes visible the already existent complexity of knowledge contributions being leveraged, as well as highlighting their significances for intervention-into-context. The bases of legitimation for knowledge within an ecology of knowledges are articulated in more detail in the think-piece in Appendix 11, in terms of internal and external bases of legitimation.

b. Ecology of temporalities

Within this ecology, the monoculture of linear time is confronted with the recognition that linear time is only one among many other conceptions of time, and that its predominance is a result of the primacy of western modernity, rather than its primacy as a temporal conception (Santos, 2004). It embraces the constellation of diverse times and temporalities, modern, non-modern, ancient, and recent, which are activated differently depending on context within the subjectivities and identities of individuals and social groups (Santos, 2004). Santos argues that the most resistant relations of domination are based on hierarchies among temporalities, where domination takes place by reducing those undesirable, dominated or hostile social experiences to the condition of residuum; and that experiences are designated as residual when they are contemporary in ways that are not recognisable by the dominant temporality (Santos, 2007, 2004).

Santos points out that since different knowledge practices “take place on different spacial scales and according to different durations and rhythms, inter-subjectivity entails also the disposition to know and act in different scales (inter-scalarity) and articulate different durations (inter-temporality)” (Santos, 2007:14). A pertinent illustration of this in relation to social-ecological risk is the tension between the timelines of formalised knowledge production, and those of context-driven urgency as risks begin to manifest and impact on people’s lives. Such duration differentiation demands an expansion of temporal frames in order to accommodate diverse forms of knowledge and their knowledge practices which arise in relation to such social-ecological complexity. If we relate Santos’ arguments here to Latour’s articulation of ‘matters of fact’ and ‘matters of concern’, we begin to recognise the significance of ecologies of temporalities. The establishment of ‘matters of fact’ require often extended processes of research, testing and technology development, in addition to those systems of patenting and production which have become extensions of the modern scientific knowledge production process. ‘Matters of concern’ more easily allow the integration of, and movement across, multiple temporal scales, and seek to privilege those knowledge processes which enable urgent response to contextual risk, while also recognising the contribution of ongoing knowledge work in relation to such risk. The sociology of absences embraces the idea that societies (and individuals within societies) are constituted of constellations of temporalities, and that once these temporalities “are recuperated and become known, the practices and sociabilities ruled by them become intelligible and credible objects of argumentation and political debate” (Santos, 2004:20-21).

c. Ecology of recognitions

This ecology challenges the colonality and unequal sexuality of western capitalist hegemony which collapses difference and inequality, while at the same time, claiming the privilege to ascertain who is equal or different (Santos, 2004). Santos points out that although,

in all logics of production of absence the disqualification of practices goes hand in hand with the disqualification of agents, it is here that the disqualification affects mainly agents, and only secondly the social experience of which they are the protagonists (Santos, 2004:21).

Here, the sociology of absences confronts colonality (including race) and unequal sexuality by seeking new articulations between principles of equality and difference, thereby enabling the possibility of equal differences which are comprised of mutual recognition. This is done by interrogating hierarchy through critical ethnography (Santos, 2004; also see Latour, 1993 for a related critique). This ecology consists in deconstructing hierarchy (to what extent is hierarchy a

product of difference?), and difference (to what extent is difference a product of hierarchy?) (Santos, 2004). Those differences which remain once hierarchy is dismantled, provide the basis for a powerful denunciation of those differences that hierarchies entrench in order to sustain themselves (Santos, 2004).

d. Ecology of trans-scales

Here, the sociology of absences works to reclaim in the local, that which is not the result of hegemonic globalisation. Contrasted with this are those aspects of the local which have been integrated into hegemonic globalisation, which Santos (2004) refers to as localised globalism. Additionally, this aspect of the sociology of absences also explores the possibility of counter-hegemonic globalisation as an opening towards de-globalisation of the local, and its eventual counter-hegemonic regionalisation.

The sociology of absences requires in this domain the use of cartographic imagination, whether to see in each scale of representation not only what it reveals but also what it conceals, or to deal with cognitive maps that operate simultaneously with different scales, namely to identify local/global articulations (Santos, 2004:22).

e. Ecology of productivities

In response to the monoculture of capitalist productivity, the sociology of absences is concerned with recuperating and valorising alternative systems and notions of productivity. Santos suggests that this might be the most controversial of the ecologies in that, "it confronts directly both the paradigm of development and infinite economic growth and the logic of the primacy of the objectives of accumulation over the objectives of distribution that sustain global capitalism", (2004:22).

In summary, the intention of the sociology of absences is to identify and give credit to the diversity and pluriversity of social practices in opposition to the exclusive credibility of hegemonic practices (Santos, 2004). The notion of ecology also invites the possibility of multiplicity and nondestructive relations (Santos, 2004).

Common to all these ecologies is the idea that reality cannot be reduced to what exists. It amounts to an ample version of realism that includes the realities rendered absent by silence, suppression, and marginalization. In a word, realities that are actively produced as nonexistent (Santos, 2004:23).

Exercising the sociology of absences is thus counterfactual and confronts conventional scientific common-sense without dismissing the potential contributions of scientific forms of knowledge out of hand. Engaging the sociology of absences demands,

... both epistemological imagination and democratic imagination. Epistemological imagination allows for the recognition of different knowledges, perspectives and scales of identification, analysis and evaluation of practices. Democratic imagination allows for the recognition of different practices and social agents (Santos, 2004:23).

Each has both a deconstructive dimension, in the form of the critiques of logics of hegemonic rationality, and a reconstructive dimension in the form of the corresponding ecologies (Santos, 2004). Santos also points out that deconstruction and reconstruction are likely not evenly spread within any given movement or process, and that it is possible to act in some domains, with a monocultural logic, and concurrently, with an ecological logic in others (2004). As will be demonstrated in Chapters 5, 6 and 7, this appears to be true for the field of citizen science. In this study, I focus on articulating logics of produced non-existence within three aspects of the general knowledge culture within which specific citizen science epistemic cultures are expressed (see Chapter 3), as well as the articulation of ecologies of knowledges, highlighting tensions with manifest aspects of produced non-existence within three cases studies (see Chapter 7).

2.11.3. Sociology of Emergences

Where the sociology of absences seeks to expand current knowledge practices to include wasted social experience, the sociology of emergences intends to identify signs of possible future experiences through “the symbolic amplification of signs, clues, and latent tendencies that, however inchoate and fragmented, point to new constellations of meaning as regards both the understanding and the transformation of the world” (Santos, 2007:10). Such experiences are latent within concrete social experiences - as such, it is concerned with engaging with the possible. Santos draws on Ernest Loch’s notions of ‘Not’ and ‘Not yet’ as enhancements to the philosophical notions of ‘All’ and ‘Nothing’, to conceptualise the intention of the sociology of emergences (Santos, 2007, 2004; also see Kelner, 1997; Hudson, 1982). The ‘Not’ refers to the lack of something, and an expression of will to overcome that lack; it is therefore distinct from the notion of ‘Nothing’ and also holds present the consequence that to say no to one thing is to say yes to and affirm something different (Santos, 2004). The ‘Not Yet’ is the more complex category, and the one most central to the sociology of emergences in that,

it expresses what exists as mere tendency, a movement that is latent in the very process of manifesting itself. The Not Yet is the way in which the future is inscribed in the present. It is not an indeterminate or infinite future, rather a concrete possibility and a capacity that neither exist in a vacuum nor are completely predetermined. Indeed, they actively re-determine all they touch, thus questioning the determinations that exist at a given moment (Santos, 2004:24).

This form of symbolic enlargement and imagination aims to a) assist us to discover the conditions of the possibility of hope, and b) to engage in the definition of principles of action that might enable the fulfilment of those conditions. The interest here is emancipatory intervention in support of the realisation of concrete counter-hegemonic³² utopias (Santos, 2004). Because the 'Not Yet' has meaning (as possibility), but no predetermined direction, it replaces the idea of determination with that of care (Santos, 2004). This axiological charging takes a different form in each sociology - in the sociology of absences care is enacted through systems of alternatives in the present, while in the sociology of emergences, it is exerted through possible future alternatives (Santos, 2004). Similarly, where the sociology of absences is enacted in the field of social experiences, the sociology of emergences is enacted in the field of social expectations (Santos, 2004). Santos explicates that the sociology of emergences,

conceives of the discrepancy between experiences and expectations without resorting to the idea of progress [as in western modernity] and seeing it rather as concrete and measured. The question is not to minimise expectations, but rather to radicalize the expectations based on real possibilities and capacities, here and now (Santos, 2004:27).

In sum, the sociology of emergences is "the inquiry into the alternatives that are contained in the horizon of concrete possibilities" (Santos, 2004:25). It brings into the present, a possibility that is uncertain and never neutral, and "valorizes clues as pathways toward discussing and arguing for concrete alternatives" (Santos, 2004:28). The sociology of emergences speaks to Latour's (2004) arguments related to 'matters of concern', in that it is always seeking future possibility, however uncertain, and holds this in tension with what is possible in the present, as well as how the present might accommodate or facilitate a different future. This is of relevance to understanding the epistemic cultures of citizen science projects because it shifts the debate about what counts as legitimate knowledge contributions away from fact-based knowledge production and into the domain of always unfolding, risk-responsive knowledge production. This speaks to one of the arguments in the field of citizen science, concerned with the legitimacy of citizen science knowledge contributions compared to professional scientist contributions, once again expanding notions of legitimacy which become referenced by unfolding and evolving social-ecological risks, rather than only the establishment of objective facts.

³² While Santos leverages the term 'counter-hegemonic', I use the term post-abyssal expansion to overcome setting up an unintentional dualism in the study, and to hold present the intention to enable epistemic expansion. Post-abyssal expansions are counter-hegemonic in the way that Santos describes (2004).

2.11.4. Intercultural Translation

In order to coherently enact an ecology of knowledges, Santos identifies two issues that must be overcome: a) given epistemological differences, how do we go about comparing ways of knowing, and b), given the infinite plurality of knowledge, how do we create set ways of knowing that enable participation in an ecology of knowledge? (Santos, 2009). The second part of this is dealt with in more detail in Appendix 11. Santos' notion of intercultural translation provides a starting point for the first. Santos begins by pointing out that "[e]mbedded in different Western and non-Western cultures, such experiences use not only different languages but also different categories, symbolic universes, and aspirations for a better life" (Santos, 2007:16). Knowledges then, are composed of two related aspects: knowledges and practices. Whether as regards knowledges or practices, translation work aims to bring into visibility what unites or separates different systems of epistemic activity and social practices in order to ascertain possibilities and limits of articulation among them. Translation work, therefore, aims to create intelligibility, coherence and articulation within a counter-hegemonic world which embraces and is enriched by multiplicity and diversity (Santos, 2007, 2004).

As concerns knowledges, Santos uses the notion of intercultural translation to bring attention to the intentional work of interpretation and articulation between two or more knowledges. This is not a matter of reconciling full bodies of knowledge with other full bodies of knowledge (western scientific knowledge with Vedic knowledge for example). Instead, intercultural translation is a process that is bounded to a particular issue within context. This could involve identifying similar concerns or aspirations, and the diverse responses that different knowledges are able to provide, or the differences and conflicts between them, and how these relate to or impact on contextual challenges. Santos notes that "[t]hrough translation, it becomes possible to identify common concerns, complementary approaches, and, of course, also intractable contradictions" (Santos, 2007:16).

A shared matter of concern could also provide the stimulus for intercultural translation, as those with overlapping concerns seek to contribute different forms of knowledge towards resolving shared concerns. Through interactions, translation work reveals weaknesses and strengths within each form of knowledge, revealing perspectives unavailable through any other knowledges, as well as inherent ignorances. For Santos, this process results in an opening or contact zone for

dialogue, mutual knowledge, understanding and identification which go beyond the conceptual and terminological distinctions and towards commonalities from which practical aggregations for action are able to emerge (Santos, 2004). Santos stresses that this is not a process of appropriation obtained through cultural cannibalisation; it is a mutual task with translation work flowing both ways, towards resolving a shared concern (2004).

As concerns practices: Here, the focus shifts to mutual intelligibility among objectives, styles of action, types of organisation and forms of struggle (Santos, 2004). Santos clarifies that the,

specificity of the translation work concerning practices and their agents becomes clearer in situations in which the knowledges that inform different practices are less distinguishable than the practices themselves. This happens particularly when the practices take place inside the same cultural universe [for example, two biodiversity conservation organisations or two water-rights groups] (Santos, 2004:131).

The overarching aim of translation between knowledges is to enable and establish systems of epistemic justice through epistemic imaginations. The aim of translation between practices and their agents, enables and promotes conditions for global-social and social-ecological justice through democratic imaginations; “The objective of the translation work is to create constellations of knowledge and practices strong enough to provide credible alternatives to the current phase of global Capitalism, colonialism and patriarchy” (Santos, 2014: 233). Translation work is a risky and uncertain endeavour.

Santos has assembled a set of questions as starting points for translation work, in order to bring some of the power dynamics into visibility (Santos, 2004).

What should be translated? From what do we translate, into what? When should we translate? Who should do the translation work? How should the translation work be done? Why should we engage in translation work?

Translation becomes possible within what might be referred to as ‘contact zones’ - those spaces where diverse practices or knowledges interact, and willingly and reciprocally evaluate their normative aspirations, knowledges and practices as they engage with and seek to articulate ‘matters of concern’. This is possible only to the extent that unequal power relations are able to yield to relations of shared authority (Santos, 2009, 2004). Both active and passive selection occurs. Active selection describes those practices a social group chooses to bring into contact for translation; passive selection recognises that in all cultures, there are some things which have become unpronounceable due to extreme forms of oppression and absents to which they were subjected over extended periods of time.

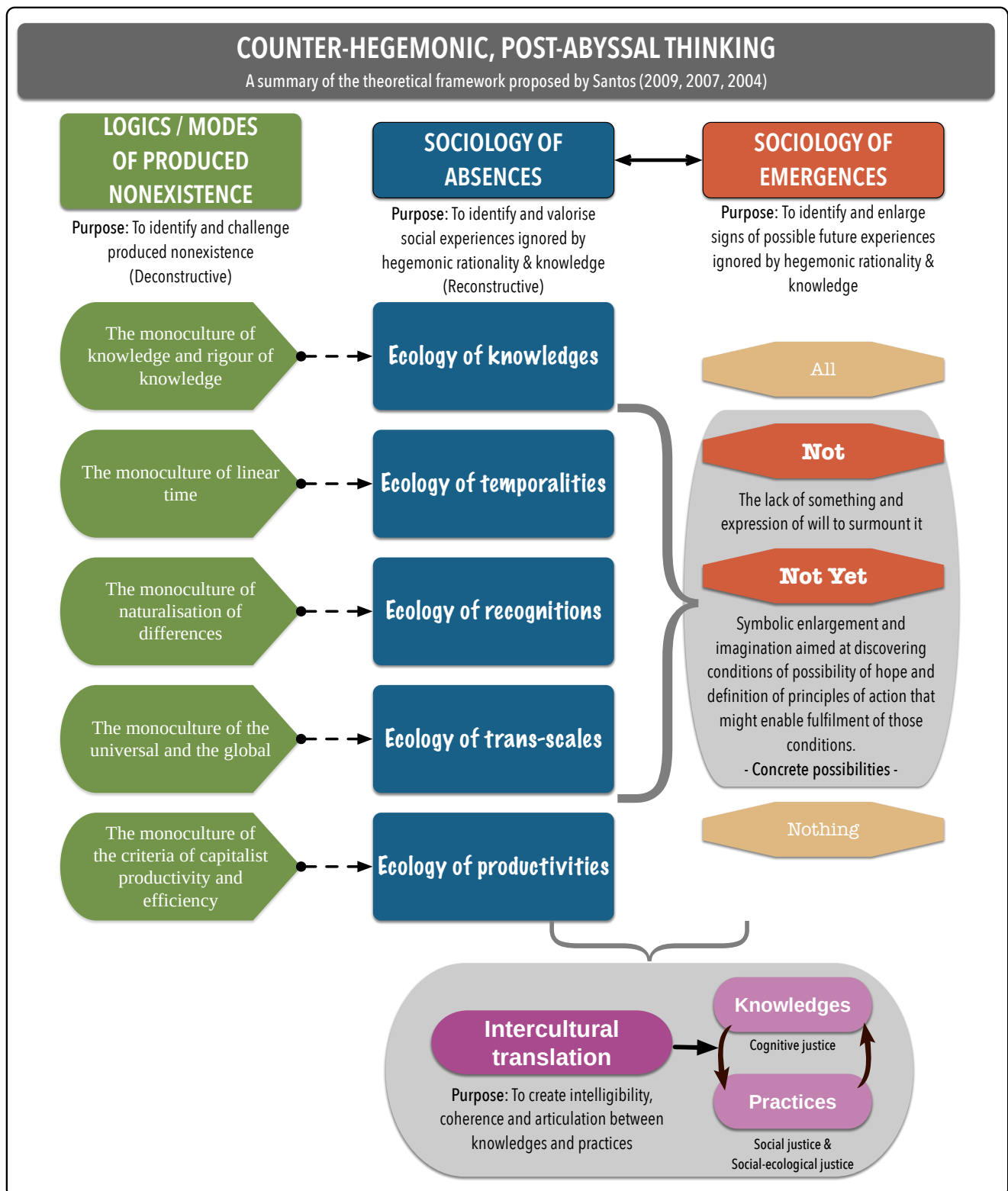


Figure 9: A visual summary of Santos' system of post-abysal thinking (Santos, 2004).

Another challenge is that different participants engaged in translation activities may have different levels of mastery of the languages selected for translation, as well as diverse criteria for how knowledges and practices are legitimated or validated. For example, Garvin (2001) provides a useful demonstration of the diverse ways in which scientists, policy makers and

members of the public validate knowledge claims, and Felt et al.³³ (2009) illustrate the power that scientists wield when science is used as the language of translation regardless of institutional intentions (see for example, Shava, 2009). Santos (2004:137) points out that in many cases, a dominant language which is well-established within hegemonic cultures, is selected for translation, and that such languages are “responsible for the very unpronouncability of some of the central aspirations of the knowledge and practices that were oppressed in the colonial contact zone”. A further challenge to translation concerns silences - where words and silences together articulate different meanings, and where silences are ascribed meaning (Santos, 2009, 2004; also see Felt et al., 2009). These and other challenges require navigation in translation work.

Santos (2004) summarises the epistemic offering of this theoretical framework noting that enlarging of the field of experience makes possible an evaluation of better alternatives in response to situated risks. This diversification of experiences facilitates a recreation of the tension between experiences and expectations in ways that bring them into the present (*ibid*). The possibility of a better future is not related to some future time that never arrives, but is rather concretised in the reinvention of the present, which has been enlarged by sociologies of absences and emergences, and rendered coherent by the work of translation (2009, 2007, 2004) and expansive learning as commoning.

2.12. Conclusion

In this chapter, I have outlined a theoretical framework which provides a particular perspective on epistemic cultures. In the first section, I outlined Cetina’s (2007) notion of epistemic cultures and laid the groundwork for a relational conception of knowledge work, in alignment with my earlier arguments. Cetina challenges hegemonic conceptions of knowledge production which view science as a single unified epistemology. Demonstrating through her empirical research, the internal plurality of scientific epistemologies - she appends that important ‘s’ to the end of science - and takes us to the recognition of sciences. Cetina’s work provides an epistemic framework through which to begin articulating epistemic cultures, and forms a core part of the analytical framework of this study. The practice-oriented nature of her notions of epistemic cultures are a strength when considering the cultures of citizen science practices. Much of the

33 Felt, U., Fochler, M., Müller, A., & Strassnig, M.

debate regarding knowledge produced through citizen science approaches is focused on the legitimacy of what is being produced, with little understanding of how or why it is being produced. Cetina's (2007) theorisation shifts analysis of what knowledge has been produced (and judgements of its legitimacy), toward how knowledge is being produced, and importantly how knowledge is being warranted and legitimated.

Latour (2004) contributes to Cetina's arguments, highlighting the problematic of dualistic ontologies in response to social-ecological risk. He begins the work of reconciling nature and society into a single embroiled pluriverse. Latour's shift from 'matters of fact' to 'matters of concern' restore to us a more dynamic epistemic mobility and the ongoing ability to (re)think, reconstitute and (re)stor(y) in the context of still unfolding, still evolving social-ecological risks. It affords the opportunity to bring 'back into view' the far from objective systems, processes and incentives for generating knowledges in particular ways, thereby enabling the possibly for re-aligning stronger justices. In the context of citizen science, this mobility is needed to reconnect unfolding risk with producing knowledges that are responsive to those risks, and also for reconnecting the motives, interests and benefits that different epistemic subjects collaborating through citizen science approaches back into epistemic practices, and the benefits associated with such practices.

Latour (2004) and Cetina's (2007) works are extended by Santos (2004), who expands epistemology to those knowledges which have been de-legitimated by hegemonic rationality, again, extending us from a dualistic ontology into pluriversality. Where Latour's work maintains a focus on strengthening scientific forms of reasoning, Santos argues for the recognition of knowledges which are only partially, or not, reconcilable to science, reclaiming their epistemological legitimacy. Convening multiple forms of knowledge into particular knowledge production processes provide a mechanism to disrupt and expand the potentially self-referential cultures within a discipline, giving rise to an expanded, and by necessity, more complex and dynamic system of knowledge production. In this thesis, Santos's work (2004) affords the epistemic opportunity to first make citizen science knowledge contributions which have been produced as non-existent visible, then to recognise issues of social-ecological injustice (including epistemic, contributory and distributive injustices), and finally to (re)stor(y) and reconstitute epistemic activity as enactments of participatory and/or radical democracy. In doing so, possibilities and potential for commoning and constituting common goods are expanded upon,

and wasted social experiences are reclaimed as legitimate contributions to common knowledge production in response to risk. The benefits of doing so as relates to citizen science are evidenced in Chapter 7 especially.

A second post-abyssal move opened by Cetina (2007) is a conception of knowledge as arising in practices and knowledge processes, which root them firmly within the contexts through which they arise. A significant outcome of this argument is that it calls into question the claim of objectivity within the sciences, and calls on us to recognise that while particular forms of scientific knowledge production might exclude subjective elements, they are never free of the subjectivity of their producers. Latour deepens this argument by challenging the legitimacy of the construction of 'matters of fact', especially as they relate to social-ecological risk; he strengthens the post-abyssal argument by forwarding the development of propositional knowledge - 'matters of concern', instead. 'Matters of concern' centralise a stronger interest in social-ecological justice, reconnecting scientific knowledge to the politics of its producers, and to any impacts on consequences in the world. Santos, again expands on this by centralising the relationship between epistemic justice and social-ecological justice, calling on us to recognise the waste of social experience and the deep injustice enacted through hegemonic rationality. All three authors centralise context within epistemic activity, and Latour and Santos go as far as to argue that the ability to intervene into context should be a primary basis of legitimation for knowledge production.

Both Latour and Santos also share an interest in the common good (which between them, they also refer to as 'the good life', 'good common world', 'good cosmos'). For Latour, these terms designate the harmonious unification of external realities in ways that enable us to draw on multiple forms of knowing to construct a series of propositions about a 'matter of concern'. Latour (2004) talks about the 'progressive composition of the common good world' as the diplomatic work involved in understanding the relationships between different propositions and associations of subjects and objects. This resonates with Santos' (2004) notion of inter-cultural translation, and the work involved in coming to understand views and framings from diverse knowledges. Both of these processes acknowledge that an association between and among objects and subjects can hold one set of meanings and significances within one form of knowledge, and that the same relationship can hold a completely different set of meanings and significances within a different form of knowledge; Latour goes so far as to propose that the

same association can in fact hold multiple meanings within a single knowledge (2004). The task then, is to begin to understand how and why these meanings and relationships arose, how they can be diplomatically reconciled, and how each could potentially contribute to the resolution of complex contextual risk. Engaging knowledge politics provides the epistemic ground for reconsidering strengthening epistemic justice, and the associated contributory and distributive justices within the epistemic cultures of citizen science projects.

In the next chapter, I engage more deeply with modes of produced non-existence, within general knowledge cultures which demonstrate more specifically, the limitations and injustice of hegemonic rationality - especially in response to social-ecological risk.

I pick these lines of arguments again in Chapter 4, where I grapple with how to enact such post-abysal processes in the doing of this particular piece of research. Methodologically, Law (2004:122) points out that if the world is indeed multiple, indefinite and emergent, then we need,

ways of exploring the enactment of and the interactions between different realities [...] [t]here is a need for tools that allow us to enact and depict the shape shifting implied in the interactions and interferences between different realities [...] [t]here is need for procedures which re-entangle the social and the technical.

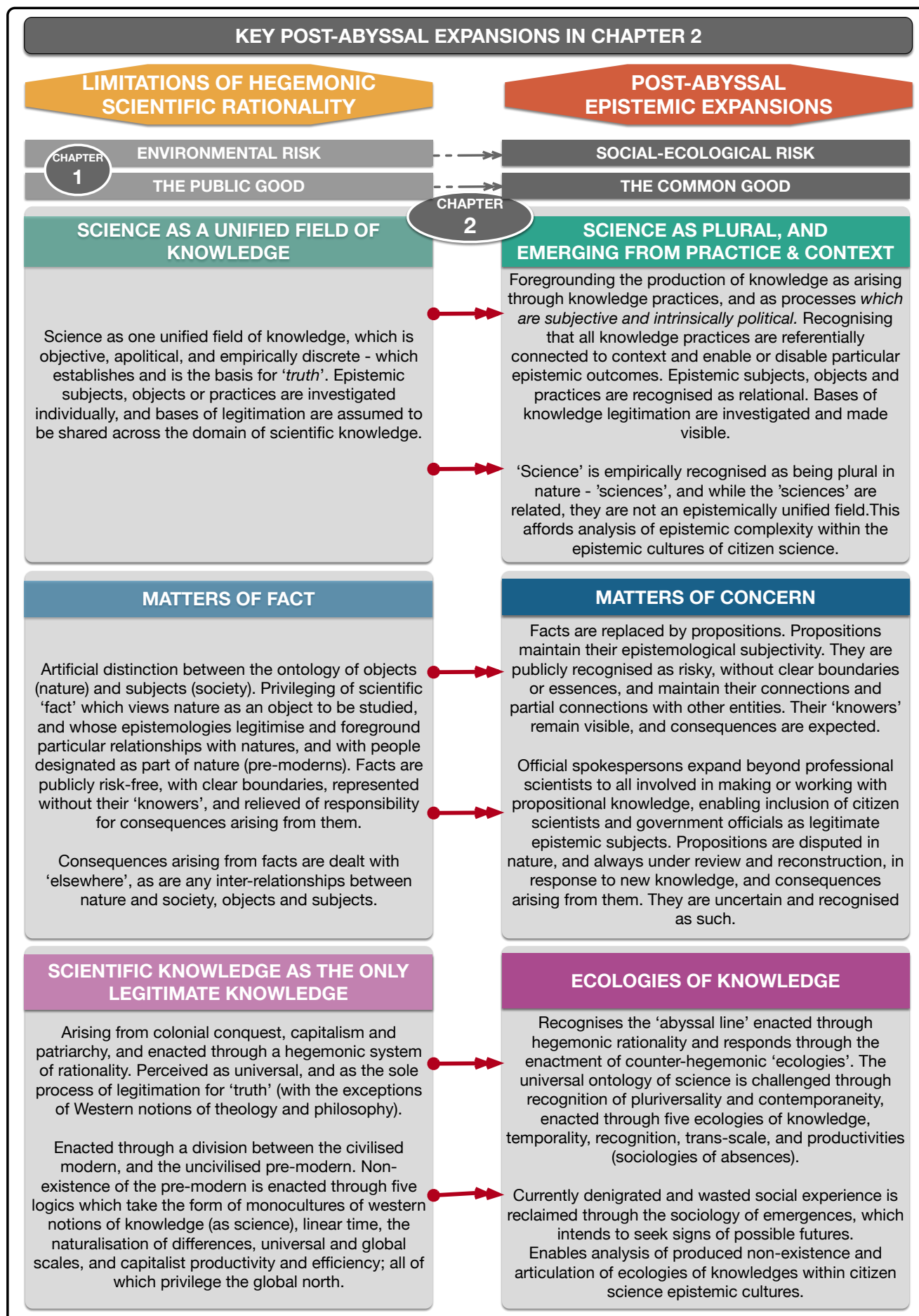


Figure 10: Visual summary of post-abyssal expansions in Chapter 2

CHAPTER 3

General Knowledge Cultures: Three Expressions of Produced Non-Existence

Be careful when speaking. You create the world around you
with your words.

Diné (Navajo) proverb

“It matters what ideas we use to think other ideas”

Strathern (1992:10)

“It matters what thoughts think thoughts.

It matters what knowledges know knowledges.

It matters what relations relate relations.

It matters what worlds world worlds.

It matters what stories tell stories.”

Haraway (2016:38) drawing on Strathern (1992)

3.1. Introduction

There is a substantial body of work identifying, theorising and problematising the contemporary social-ecological crisis. Read together, these perspectives highlight the complex, evolving and uncertain nature of our understanding of the world (ecological, social, and systemic), and our relationships to it. They raise the need to move beyond techno-scientific understandings of the environmental crisis, towards more complex, relational ways of both understanding and intervening in the world in response to social-ecological risk - especially if one intends on commoning towards the common good (see 1.5.4).

Currently, scientific rationality and systems of legitimation dominate as the often sole criteria of knowledge legitimation. The assumption is that society as a whole shares such scientific definitions of truth and rationality (Garvin, 2001; also see arguments presented in Chapters 2), while consensus or at least majority-based forms of consensus are often seen as the primary form of political legitimation, as argued by Árnason (2013), for example. Scientific and State systems work together to reinforce, defend, and promote the supremacy of scientific knowledge over other knowledges, and project science as the most credible form of knowledge for decision-making (Santos, 2004; Latour, 2004; Law, 2004; Garvin, 2001). Therefore, in order to foreground participatory, radical, pluriversal democracy, and an interest in the common good, questions of a) what counts as credible, authoritative and legitimate knowledge, b) whether a single base of legitimation is sufficient, democratic and just, and c) who is to determine what counts as a legitimate knowledge contribution, all require review and ongoing engagement. A central issue of concern might be a lack of robust theoretical foundations for authentically bringing together scientific expertise with other forms of expertise, scientific knowledge with other forms of knowledges, and integrating radical and pluriversal democratic processes into both scientific knowledge production and policy implementation mechanisms of such knowledge into the lived world (see for example, Bäckstrand's arguments, 2003).

The aim of this chapter is to consider the general knowledge cultures (Cetina, 2007) within which the specific epistemic cultures of citizen science projects are located. To do so, I engage in three lines of immanent critique; each critique brings to the fore a different aspect of knowledge cultures for examination:

Critique 1: Knowledge production within modernist western sciences: A critique of ontological dissonance

Critique 2: Science and its publics: A critique of knowledge flow

Critique 3: The construction of environmental risk within the Anthropocene: A critique of knowledge production in response to risk

Informed by the work of Santos (2016a, 2007, 2004), the critiques are formulated as 'sociologies of absences' which aim to make visible what has been rendered invisible, and the consequences of these choices for knowledge production within the general knowledge cultures as relates to social-ecological risk and the common good. Santos (2004:14-15) argues that,

what does not exist is in fact actively produced as nonexistent, that is, as a noncredible alternative to what exists. Its empirical object is deemed impossible in the light of conventional social science, and for this reason its formulation already represents a break with it. The objective of the sociology of absences is to transform impossible into possible objects, absent into present objects.

As a 'sociology of absences', the work of this chapter is to understand how some (or even much) knowledge being produced through the epistemic cultures of citizen science projects might be foregrounded or rendered nonexistent. Much of the critique leveraged against citizen science-produced knowledge arises in the guise of scientific warranting of such knowledge³⁴, and so the first critique considers the basis of legitimation of modernist science. Another grouping of critique leveraged against citizen science-produced knowledge is formulated based on pre-established relationships between science and its publics, and within the constructs of the science-policy-public interface. The second critique speaks to this by considering the relationships between science and its publics. Finally, the third critique considers the way in which social-ecological risks, to which citizen science projects aim to respond, is predominantly constructed. Here, I specifically foreground the concept of the Anthropocene, which has come to dominate narrations of environmental and social-ecological riskiness³⁵. Each of these critiques

³⁴ For arguments pointing to this tendency, see for example, Elliott, K. C., & Rosenberg, J. (2019); Jollymore, A., Haines, M. J., Satterfield, T., & Johnson, M. S. (2017); Heiss, R., & Matthes, J. (2017); Burgess, H.K., DeBey, L.B., Froehlich, H.E., Schmidt, N., Theobald, E.J., Ettinger, A.K., HilleRisLambers, J., Tewksbury, J. and Parrish, J.K., (2017); Kosmala, M., Wiggins, A., Swanson, A., & Simmons, B. (2016).

³⁵ A fourth critique - The operationalisation of the Abyssal Line: The moral negation of the other - was pragmatically removed in an attempt to reduce the density of this research. Within this critique, I considered the moral negation of the other which enabled a shift in ontological status of others into 'nature', thereby legitimating the colonisation of people and territories, and the genocides, epistemicides and eco-piracies that arose on the basis of such moral negation. This is an important critique because it reclaims the humanity and the right to participate in ontological debate, and ontological choices that were undermined through such moral negations. It is a critique I intend to revisit in future, but for now, will simply flag for the reader.

is leveraged on the basis of arguments presented in Chapters 1 and 2. Each of the critiques build on the others, and expand the arguments presented.

I remind the reader that this chapter was written after the data analysis chapters, in an attempt to understand the epistemic dissonance between what was evidencing itself in the field of practice, compared to what I was observing in the literature. It speaks to the explanatory gap between practice, scientific reporting and other official forms of reporting, and considers the implications of that gap in light of Santos's arguments of produced nonexistence. The arguments in this chapter illuminate criteria used to inform the analytical structure for reading scientific literature about citizen science presented in Chapter 5.

This chapter is not intended to diminish or discard the substantial contributions of scientific ways of enacting the world that have been constructed thus far. Instead, it is intended to (re)look, (re)story, and (re)member these enactments - to recognise how we have arrived at our current processes of knowledge production in response to social-ecological risk, and to consider where these enactments are no longer (or have never been) just or robust enough to equip us to secure common goods into our common futures. As I write these critiques, I am constantly asking myself: what is use-able, what is just, what can be reclaimed, and what needs to be transcended and re-imagined?

Critique 1:
Knowledge Production within
Modernist Western Sciences:
*A critique of ontological
dissonance*

3.2. Knowledge Production within the Modernist Sciences: A Critique of Ontological Dissonance

Science is the primary basis of legitimation currently being used within the field of citizen science (as demonstrated in Chapter 5), and foregrounded in the name itself - citizen *science*. However, Visvanathan (2006:167) points out that, “[o]ne participates in science, one extends it, one questions scientifically but one does not question science”. And yet, if science is to be the dominant epistemology through which we come to know, and later act on and in the world above all others, then it is imperative that we first be able to question the legitimacy of its claim as the epistemology above all other epistemologies. The aim of this critique is to more clearly and critically articulate, at a more general level, the epistemic features and practices of scientific knowledge production, and the basis through which such knowledge is organised, and rendered legitimate or illegitimate, in order to evaluate its current role in citizen science-based forms of knowledge production.

This first critique engages more deeply with the epistemic practices shaping scientific forms of knowledge production. I begin by considering the mediational role of ontological dualism and its dualistic sorting tendencies. I then briefly outline how dualistic sorting might be enacted, before considering two perspectives on ontological re-integration for modernist science. The first is Latour’s re-constitution between nature and society (1993). The second is a consideration of ontological possibilities offered through quantum physics.

As evidenced in Chapter 7, citizen science projects enact complex and diverse epistemic cultures, which draw on a range of knowledges to build common knowledge. This critique of ontological dissonance is important because it provides insight into both the bases of epistemic legitimation for some forms of knowledge, and the denigration of others within scientific terms. These insights equip us to consider the legitimacy of dualistic sorting in epistemic activity.

3.2.1. Dualism in Action Through Dualistic Sorting

Dualistic sorting describes the mediational process through which modernist scientific knowledge is organised and ascribed value (Jones, 2010). As will be evidenced in the data chapters of this thesis (Chapters 5, 6 and 7), this mediational process is significant in that it ascribes value to diverse knowledge contributions, and provides the bases of legitimation for

epistemic authority and recognition, as well as resource distribution in response to social-ecological risk, within citizen science practices. This section provides an initial orientation to how dualistic sorting is operationalised.

Jones (2010) argues that the ontological basis of western epistemic cultures and their attendant knowledge practices take a Cartesian ontology of the world as the naturalised foundation of rational thought, in spite of the diverse contentious implications of this starting point for knowledge building and social practices within the world. The ethicist, Charles Taylor (2007, in Jones, 2010) points out that Cartesian dualism has a mediational standing in contemporary society - that is to say that modern science and much of contemporary life is mediated through the ontological assumptions of Cartesian dualism. With the rejection of substance dualism by many scientists across a range of disciplines, much of this mediation has fallen from view while continuing to remain pervasive in the ways that we think, speak and enact the world.

Visvanathan (2006), Jones (2010), and Latour (1993) all argue in one way or another, that this ontology of the world is itself a cause of many of the social-ecological issues it seeks to address - an idea that is explored further in the remainder of this chapter. Significantly for this thesis, the ontology through which we view the world impacts on the way we identify problems, how and where we look for the sources of those problems, and finally, the types of knowledge, solutions and values we choose to foster in response to those problems. In this regard, Jones (2010:117) contends that,

[o]ne of the consequences of this picture is that epistemological, moral and ontological questions are inextricably intertwined. None of our claims about the world, whether they are about the physical world or the nature of human beings, can be based upon absolute, unquestionable observations about what is fundamentally real. Similarly, none of our moral claims can be based upon some starting point of absolute or unquestionable knowledge, because there are always assumptions about the nature of human beings that we take as a starting point for our moral reasoning. Our choice of background assumptions necessarily affects moral choices as well as choices about epistemology and ontology ... assumptions about the nature of knowledge impact our ideas about what is right and wrong.

If we are to take seriously a call towards the common good, then we need to understand the the ontological, epistemological and axiological roots and implications of scientific knowledge production, as geared towards this call.

In response to the growing recognition of the causal and ontological interdependence between mind and body (and mind, body and environment) within scientific knowledge production,

Dempsey (2009) differentiates between substance and property dualism, arguing that while substance dualism has seen rapid decline, property dualism remains an issue and continues to enjoy significant support (also see Jones, 2010). For Dempsey, substance dualism describes that Cartesian dualism which perceived the mind as an immaterial substance capable of independent existence; property dualism on the other hand embraced a reconceptualisation of the nature of matter, shifting from inert and passive to active in its own right (*ibid*). Where substance dualism argues that body and mind are different substances, property dualism argues for an interconnected system between mind and body, while recognising the differentiated properties of each, mind with its expansive subjective nature, and body with its fixed and objective reality (*ibid*). Dempsey (2009) notes that this ironically leaves us in the midst of a property dualism that retains and maintains the explanatory gap between the functioning of the physical world and the emergence and expansion of consciousness.

Slife, Reber and Faulconer (2012) add that it is in the perspective that subjectivity and objectivity have two distinct ontological realities that contemporary dualism is most often made manifest. They explain that,

[a]ccording to subject-object dualism, the subjective world consists of our opinions, feelings and meanings, whereas the objective world consists of the objects and laws of the world ... [t]hese two "worlds" are generally considered to have distinctly different qualities (Slife, Reber & Faulconer, 2012:4).

While interaction between these realms exists, the interaction arises from different and ontologically independent realities from each other (*ibid*) (what Latour, 2004, 1993, describes as two distinct universes). Drawing on Taylor, Jones (2010) notes that fundamentally, this leaves us in a position of seeing the world in terms of an inner (the mind) / outer (the rest of reality) split. He points out that the,

imposition of the inner-outer structure of Cartesian epistemology brings with it a number of problems and consequences. The boundary between the inner world of the mind and the external world of everything else creates problems for epistemology. There are now two sources of knowledge (Jones: 2010:119).

As Jones makes clear, reconciling these two sources of knowledge, and making knowledge about the outside world available for inner reasoning becomes challenging - especially when the rules governing each form of knowledge are substantively different from each other, and what we seek to establish and maintain on each side of the boundary is likewise markedly distinct (2010; also see Latour, 1993). On the side that governs the outside world, we strive for a scientific understanding which brings with it causal objective knowledge that intends to

represent accurately everything which happens. On the side that governs what happens internally, we seek epistemologies that allow for the possibility and promotion of individual freedoms which enable us to be in the world in ways that go beyond causal reactions to external stimuli (Jones, 2010). Taylor argues that the process of Cartesian disengagement implicit in this form of rationality enables us in part to talk about universal experiences which transcend individual experience and to objectively observe physical reality in a way that is independent of the mind; he terms this process dualist sorting (Taylor, 2007, in Jones, 2010).

3.2.2. Latour: The Limitations of Dualism as a Viable Ontology

In his book *We Have Never Been Modern*, Bruno Latour explicates how the ontological rift between dualised views of mind/body, human/nature and mind/spirit are operationalised within scientific processes of knowledge production (1993). Where the arguments above were centered on the mind/body split, Latour especially addresses the split between human/nature or society/nature, as it manifests in scientific discourse, with a strong focus on how the operationalisation of dualism within scientific knowledge production becomes increasingly questionable (Latour, 1993). At the root of Latour's argument is the claim that our particular construction of modernist science is powerful specifically because legitimization of scientific knowledge is founded on the clearly separated domains of nature and society, and this separation and its related processes of legitimation act to obscure the ontological weaknesses inherent in this form of reasoning; in other words, its authority relies on clear separation (*ibid*). Latour argues that analytical continuity has become impossible within a dualistic system of knowledge production where there is limited ability to account for the complex, evolving, intersecting links and influences between nature and society (*ibid*).

His essay lays out the argument that our objects of research are simultaneously real (like nature), narrated (like discourse), and collective (as with society), and that the artificial systems of investigating a research object as only one of these are therefore inaccurate in that they, a) render our understanding of an object incoherent when reintroduced to the open system; b) provide only a partial view and understanding of the object; and c) make invisible the relational systems of iterative co-construction between nature and society (*ibid*).

To begin with, Latour describes two Great Divides (or Abysses) through which the ontological rift is operationalised:

- 1) the Internal Great Divide - between Nature (objective reality) and Society (subjective reality);
- 2) the External Great Divide - between 'premoderns' with their relational knowledge systems, and moderns, with their dualistic knowledge systems.

He illustrates and argues that,

the two Great Divides do not describe reality - our own as well as that of others - but define the particular way Westerners had of establishing their relations with others as long as they felt modern (1993:103). ... [i]n the modern perspective, Nature and Society allow explanation because they themselves do not have to be explained (Latour, 1993:80).

Building on Jones' (2010) argument about the mediational role of dualistic reasoning, Latour (2004; 1993) extends this argument by pointing out that ontological and epistemological mediation are in fact actively rendered invisible, summarising this tendency as 'the invisibility of processes of scientific mediation'. This, Latour contends, is mechanised through the specific machineries of scientific knowledge production through which mediation is rendered invisible, and thereby beyond the sphere of critique and interrogation (1993; 2.7 outlines a more detailed version of Latour's arguments as summarised in Figure 11 below).

As concerns the first Great Divide, this is mechanised through the following:

- a) The invisibility of scientists in their facts (facts are constructed, mediated and represented through their disciplined spokespersons - scientists - facts are presented as though naturally arising, and absent of their mediating spokespersons);
- b) Facts are afforded power only when the knowledge about them is limited to the instrumentalised nature of those facts, leaving aside any interpretation of causes. This is done through the specific and controlled relationships between instruments and observers (both of which then become invisible in the presentation of the emergent facts);
- c) Sciences are considered scientific only when they officially divest themselves of their contexts, histories and perceptions - while contexts, histories and perceptions may indeed form the basis for the development of facts, they become scientific fact only when divested of context;
- d) Through clear separation between processes of purification and processes of mediation, with only purification remaining visible and acknowledged (and mediation being the work of assembling hybrids and mediating relationships);
- e) In that the 'Society' pole of the sciences bears the full weight of explanation, and the need to defend its explanations and theories, while the 'Nature' pole is able to mobilise the practices outlined above towards the establishment of 'facts', (Latour, 2004, 1993).

Extending this into the second Great Divide between 'moderns' and 'others', anything 'other' is rendered incomprehensible within the sciences through:

- a) The suppression of particular kinds of relationships as scientifically illegitimate;
- b) The rejection and de-legitimation of knowledge systems that hold unified relational ontologies;
- c) The clear and total distinction between premoderns ('them - everyone else', 'others') (with their ontologies of relationships between things and people, and people and spiritual beings), and moderns who were able to distill facts and articulate universal laws of nature, and who are constituted from Occidentals. This includes the practice of mobilising one set of criteria for the evaluation of 'premodern' knowledge systems, and another for modern sciences. The rationale for this is underpinned by the belief that westerners are distinct on the basis that they mobilise Nature as it is, rather than mobilising images or symbolic representations of Nature in the manner of other cultures. While in actuality, knowledge production processes between the two are similar - what is different is that modernist science makes invisible the underpinning relational processes of mediation on which knowledge-building is based, thereby cleaning knowledge out and purifying it (Latour, 1993, Chapter 2 considers this process more fully).

Accompanying and enabling the distinction between 'moderns' and 'pre-moderns' is a linear narration of time which is marked through techno-scientific moments, and the absolute break with the past, under-pinned by historical reconstitution - making possible a clear distinction between what is considered modern and contemporary (*ibid*; also see Santos, 2004). Similarly, the distinction is further enabled through the adoption of a 'particular universalism', in which western culture has privileged access to Nature, thereby setting it apart from others, and which defines the general framework of Nature, within which all others are situated. This, according to Latour (1993), allows westerners to identify universal truths which are applied to all other people and things. These universal truths are, of course, defined through modernist western science. The scientific method of purification within modernist western sciences then render the relational processes underpinning such universal facts invisible, and what always begins through localised research is then processed into universal knowledge. Latour (1993:108) argues that universalists,

are incapable of understanding the deep fraternity of collectives, since they are obliged to offer access to Nature to Westerners alone, and to imprison all others in social categories from which they will escape only by becoming scientific, modern and Westernized.

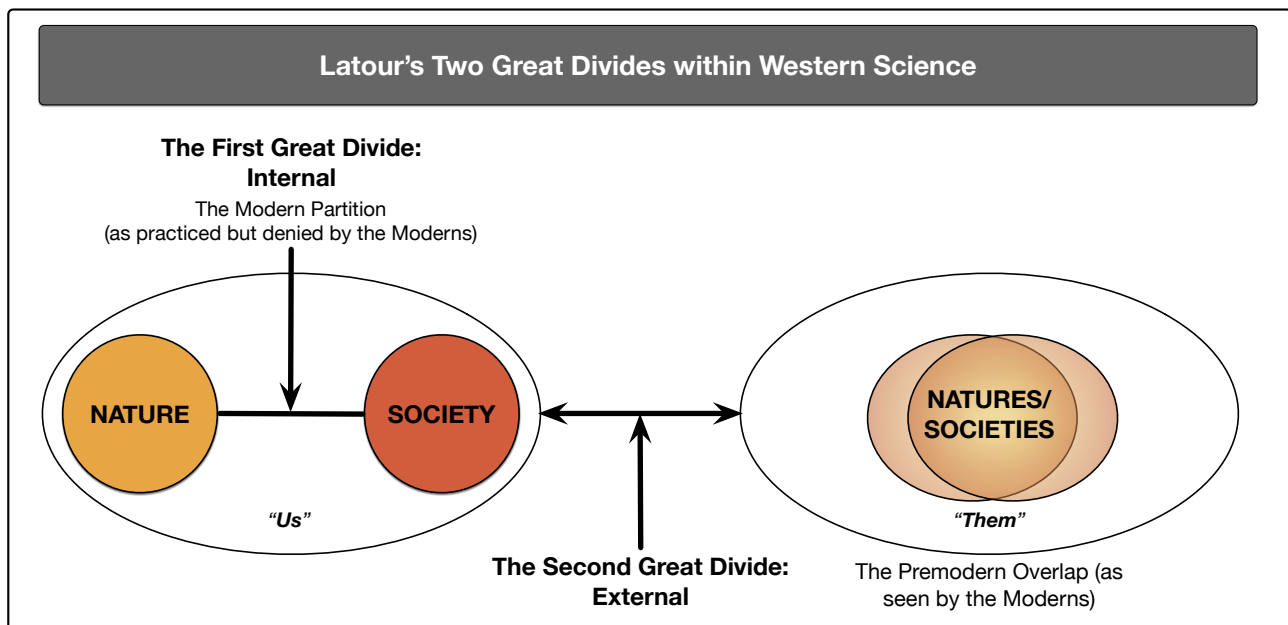


Figure 11: Latour's Two great divides within western science (Source: Latour, 1993:99)

3.2.3. Implications of Dualistic Sorting for Knowledge Production

Dualistic rationality is operationalised within knowledge production through the following mechanisms of dualist sorting (see for example, critiques by Latour, 2004; Santos, 2004; Jones, 2010; Visvanathan, 2006; Slife, Reber and Faulconer, 2012).

- Dualistic rationality provides a rational argument for the hierarchical arrangements of apparently disparate aspects of life, including groups of people;
- Through hierarchical arrangements, such rationality privileges one category over others, thereby providing a logical imperative to exploit denigrated categories in favour of privileged ones. For example, mind over body, and some bodies above others, in addition to defining denigrated categories in terms of privileged ones (white/male/modern) vs (non-white/female/pre-modern);
- It also has a reifying impact on how knowledge is worked with and represented as separate, discrete and above context, and therefore more rationally universal³⁶ (see ongoing critique in this section, and arguments presented in Chapter 2).
- Dualistic rationality provides a legitimating basis for separating out knowing and understanding something (the science) and the application of that knowledge onto the world - what we might consider 'technology' (this argument is further articulated in 2.7.1, and in the

³⁶ While there is a growing movement within the social sciences promoting the situated nature of social knowledge, research design and many processes of knowledge legitimisation still valorise generalisable knowledge. Within the so called 'hard sciences', context neutrality is still a primary basis for legitimacy.

remainder of this chapter). Visvanthan (2006) provides a useful distinction here, noting that science is conceived as universal, and technology is situated as local and adaptable.

Dualistic sorting provides the implicit, and often invisible, ontological basis through which epistemic choices are hierarchically arranged to denigrate some categories and privilege others. Figure 12 below illustrates some examples of these, drawing on the work of Latour, 2004; Santos, 2004; Jones, 2010; Cetina, 2007; Visvanathan, 2006; Law, 2004; and Slife, Reber and Faulconer, 2012.

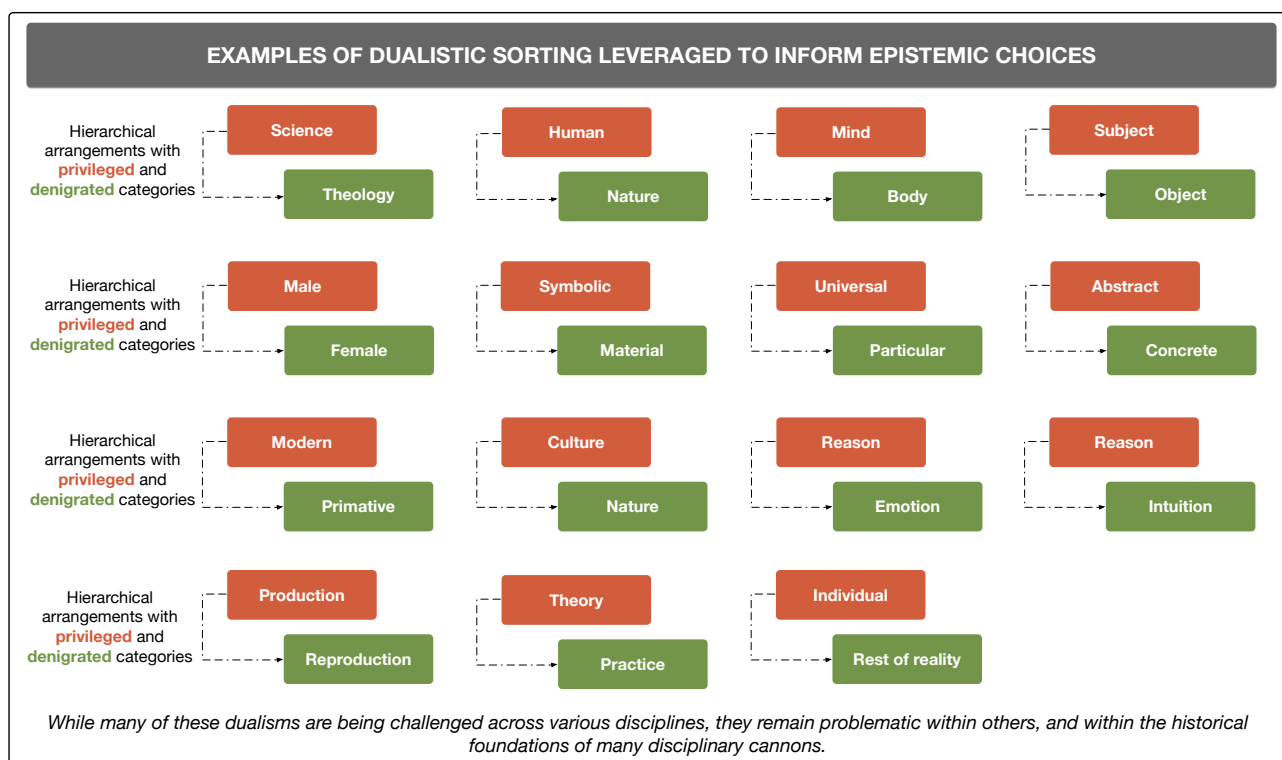


Figure 12: Dualistic sorting in practice: Examples of hierarchical dualistic relationships

3.2.4. Reclaiming a Relational Ontology for Science

As argued in Chapter 1, in order to engage in commoning and commons-building, we require a coherent relational ontology of the world - one which enables us to build collective knowledge that maintains diversity, complexity and responsiveness across scales, locations and ways of knowing and doing. The arguments in this critique have thus far focused on articulating core challenges with the predominately dualistic ontology underpinning much of scientific knowledge production. While there are, undoubtedly, a range of philosophies and arguments proposing a range of systems to reconstruct science into a relational ontology, I focus on two³⁷

³⁷ I have limited the critique to two approaches because of limitations in space. I especially would have liked to have included Roy Bhaskar's work on critical realism, as a further development of this argument, in addition to the work of feminist and queer theorists.

below because, a) both take seriously, the work of the western sciences, b) they engage the great divides and abysses, which are important for this study's post-abyssal interest, and c) they have already demonstrated an ability to generate onto-epistemic imaginaries which might be leveraged to re-imagine and (re)constitute how we produce common knowledge across diverse and complex ecologies of knowledges.

The first example is Latour's proposal for a non-modern constitution, which directly addresses his concerns regarding the two Great Divides he identifies, and which he argues are ontologically incoherent (1993). This argument is foundational to his proposed epistemological shift from 'matters of fact' to 'matters of concern' summarised in 2.7, and pertinent to this study because of the central goal of knowledge production in response to social-ecological risk within the field of citizen science. The second gestures towards the potential of the field of quantum physics as a unifying epistemology, again because it some provides promise for reconciling and reconstituting Latour's two Great Divides (1993), Santos' abyssal line (2004), and because it has already provided epistemological ground for intercultural translation (Santos, 2004).

3.2.4.1. Latour's proposal for bridging scientific divides

To overcome the inherent weaknesses and injustices of working with scientific knowledge as described above, Latour proposes that we need to re-constitute the processing of knowledge production (2004, 1993). He argues that we need knowledge production systems which allow and enable us to account for objective knowledge, power and practices together, around the nexuses of particular research objects. Underlying this is an epistemology in which Nature and Society are no longer seen as explanatory terms, but rather as something requiring conjoined explanation. Alongside this, he argues that processes of mediation need to become visible and form an appropriate and recognised role in our research into the world (Latour, 2004, 1993, also see 2.7). Latour proposes a new foundation (or constitution) upon which scientific knowledge should be produced, which should "be made capable of studying the sciences by surpassing the limits of the sociology of knowledge and, above all, of epistemology" (Latour, 1993:92). To begin with, he identifies three areas of symmetry required to strengthen western forms of science, including that:

it [Western science] uses the same terms to explain truths and errors (this is the first principle of symmetry); it studies the production of humans and nonhumans simultaneously (this is the principle of generalised symmetry); finally, it refrains from making any a priori declarations as to what might distinguish Westerners from Others" (Latour, 1993:104), without neglecting the co-

production of societies and sciences. This last calls for us to “notice that we have never been modern and that only minor divisions separate us from other collectives (*ibid*, 1993:47).

Significantly for this line of argument is the need to acknowledge the unofficial work of mediating and relating within scientific knowledge production, and to bring both into view as part of what is officially examined and considered as part of the processes of knowledge production (also see Cetina, 2007; Law, 2004; Mol, 1999). Chapter 7 evidences such a process through the analysis of three citizen science projects. Latour argues for a relational approach to reconstituting knowledge production, calling for the recognition of nature-cultures, resonating with Moore’s notion of world-ecology (2017), Cetina’s articulation of lifeworlds, and nexuses of lifeworlds (2007), and Bookchin’s arguments for social-ecology (1982).

Accompanying this is the need to reconstitute and develop more sophisticated ways of recognising and working with poly-temporal scales, rather than linear notions of time - that is, working with multiple scales which recognise the hybrid collectives of things and people which operate within simultaneous, yet diverse temporal scales (*ibid*). He insists that,

[t]ime is not a general framework but a provisional result of the connection among entities ... If we change the classification principle, we get a different temporality on the basis of the same events (Latour, 1993:74-75).

Likewise, Latour raises the need to make visible and compare the translation work of collectives, and also to dispel ‘the false problems of absolute relativism’ (Latour, 1993:127). Through these processes, natures and societies become related, and also relative products of history; they become visible and available for re-examination in new (and I argue, more powerful) ways. From Latour’s perspective, this would require the shift from ‘matters of fact’ to ‘matters of concern’, as articulated in 2.7, thereby fundamentally altering the systems of dualistic sorting underpinning mainstream modernist forms of scientific reasoning, and thereby enabling us to consider nature-cultures and the ‘sociotechnical imbroglios’ relating to and impacting them in an ongoing and always active process of knowledge production (*ibid*).

As argued in the next chapter, in the context of this study, it is the ways in which dualistic reasoning is operationalised, rationalised and imposed as the dominant and hegemonic epistemology for knowing the world that is dubious. This approach is particularly questionable because it enacts particular processes of rationalisation, which then fall from view, thereby rendering invisible what the basis of rationalisation was, and leaving behind only an

unquestioning perspective that such views are indeed rational and objectively factual. In other words, the basis of the rationality is hidden, as are the implications of such rationality³⁸, and the rationality used to generate facts and the facts themselves become functionally enmeshed, self-validating and lacking in rigour. Latour summarises that facts become 'rationalised' (and thereby legitimated as objectively superior) only through retrospective accounting processes (Latour, 2004).

Two illustrative examples of how such rigour issues are enacted (using a framing of rigour as articulated thus far in the thesis):

- a) Enmeshment related to analytical rigour: If we draw on an example of generating objective knowledge within dominant forms of scientific reasoning, the subjective theories of scientists are rendered invisible through a series of rigour-making steps which serve to reduce the visibility of scientist-subjectivity, and ground any methodology in objectivity, thereby obscuring the subjectivity and imbuing it with objective properties. This leverages the perception of a form of more fundamental truthfulness associated with objective reality.
- b) Enmeshment related to political rigour: If we consider dominant arguments currently used to legitimate particular forms of individual rights, especially as relates to property rights, we see a similar enmeshment - individual rights are rational (or more accurately, rationalised) and take primacy only within the dualistic sorting enabled through a dualistic conflation of ontology and epistemology. They are irrational within a relational ontology.

3.2.4.2. Quantum physics as a bridge between scientific divides

What quantum mechanics tells us, I believe, is surprising to say the least. It tells us that the basic components of objects – the particles, electrons, quarks etc. – cannot be thought of as “self-existent (d’Espagnat, 2009, webpage).

Here, my intention is not to attempt the impossible task of summarising the field of quantum physics. Instead, I hope to gesture towards onto-epistemic opportunities within the domain of western science which enable us to re-imagine reality(ies) with stronger ontological coherence, and which generate opportunities to begin commoning and building bridges across Latour’s two Great Divides (1993), and Santos’ Abysses (2004). While a detailed review of this school of

³⁸ I am not claiming that there are no corresponding issues in other knowledge forms - indeed, as I argue in Chapter 8, this seems to be an overarching issue in epistemological activity across many knowledge systems and ways of knowing. Here, I specifically focus on scientific knowledge as a hegemonic epistemological force globally.

thought is beyond the scope of this study, a few brief comments provide generative openings through which to consider the onto-epistemic imaginaries (see 4.5) argued for in this thesis.

Where Latour works to articulate a more coherent realist ontology for science as a process of knowledge production, quantum physics offers the opportunity to engage in scientific enquiry from an alternative ontological perspective. Where Latour's reconciliation focuses on reintegration between society and nature, and between moderns (and their dualistic ontology) and pre-moderns (and their more often, relational ontologies), quantum physics evidences again and again, a fundamentally relational ontology. Here, the *empirical evidence* of relationality has given rise to a reformulated ontology - quantum experiments evidence the relational nature of reality, and quantum theory then works to explicate what is evidenced.

Quantum physics provides an empirically demonstrable argument that the subjective and objective universes are, in fact, one single coherent universe. First, quantum physics re-organises the 'subjective consciousness' (in the western frame, this is reduced to 'mind', but is enjoying an expansion of conceptualisation into 'consciousness'), and objective reality (the materialised world), into an intimate co-creative relationship, where the power to shape 'objective' reality is restored to the consciousness, and the mind is released from a mechanised state and re-instated as creator-consciousness, thereby addressing the first divide between subjective society and objective nature (see for example, Weissmann & Larson's arguments related to objectivity and articulation of a quantum paradigm, 2017). Secondly, it begins the process of dispensing with the second divide by reclaiming an undeniably relational ontology - this reclamation shifts the bases of legitimation for what counts as knowledge. It begins to erode the arguments leveraged against 'pre-modern others', for whom quantum physics finally provides the openings to truly engage in ontological debate, and to confer meaningfully about the nature of reality. I briefly expand on both of these below. Quantum physics provides a promising scientific space of reconciliation and expansion into a more integrated and relational ontology for the commons.

The field of quantum physics takes as its unit of analysis, energy (quanta), and the way energy behaves, moves, and interacts at a sub-atomic level, thereby influencing sub-atomic and atomic

particles. Theories of quantum physics (sometimes described as quantum mechanics³⁹), provide an alternative empirical and/or mathematical articulation of reality. Gell-Mann's now famous description of the field is this:

Quantum mechanics, that mysterious, confusing discipline, which none of us really understands but which we know how to use. It works perfectly, as far as we can tell, in describing physical reality, but it is a 'counter-intuitive discipline', as social scientists would say. Quantum mechanics is not a theory, but rather a framework, within which we believe any correct theory must fit (Gell-Mann, 1981:169).

A core challenge with the account of reality encompassed within quantum physics is that it renders the theory of general relativity incoherent, bringing any dualistic realist ontology into question, and undermining its integrity from an empirical stance. Where classical science enacts and defends a dualistic ontology, which in turn enacts a compartmentalised epistemology, quantum physics foregrounds and evidences a relational ontology requiring conjoined explanations, and does so on empirical grounds. Mermin foregrounds the insight arising from the field of quantum physics, and describes,

an attitude toward quantum mechanics which, whether or not it clarifies the interpretational problems that continue to plague the subject, at least sets them in a rather different perspective. This point of view alters somewhat the language used to address these issues ... and it may offer a less perplexing basis for teaching quantum mechanics or explaining it to nonspecialists. It is based on one fundamental insight, perhaps best introduced by an analogy.

My complete answer to the late 19th century question "what is electrodynamics trying to tell us" would simply be this:

Fields in empty space have physical reality; the medium that supports them does not.

Having thus removed the mystery from electrodynamics, let me immediately do the same for quantum mechanics:

Correlations have physical reality; that which they correlate does not.

(1998:753, emphasis in original).

3.2.4.3. Bohm's implicate and explicate orders within an undivided totality

Quantum physicist and philosopher, David Bohm's work demonstrates the potential for opening dialogues with relational ontologies arising outside of classical western science, in ways that are becoming more mutually coherent. Bohm produced a large body of both physics and philosophy work. Of particular interest here, is his work on non-locality, quantum entanglement and interconnectedness of the universe at the fundamental level of quanta, through which he theorises his work on implicit and explicit orders (Bohm, 2010 [1980]). From Bohm's perspective, the explicate order (that which is empirically perceivable and observable) derives its formulation

39 For coherence, I use the two terms 'quantum physics' and 'quantum mechanics' interchangeably here. While there may well be significant distinctions in the use of the two terms within the field that are nuanced beyond my limited understanding of the space, I believe that such distinctions are less relevant at the general level of discussion provided here.

from the implicate order (the field of infinite potential through which consciousness enacts creation). This is empirically demonstrated through the possibilities which emerged through the double-slit and entanglement experiments.

According to Bohm, the ground of the cosmos is not elementary particles but pure process, a flowing movement of the whole. Within this implicate order, Bohm believed, one could resolve the Cartesian split between mind and matter, or between brain and consciousness (Peat, 1997:2).

This work contradicts the general theory of relativity, which claims locality and limitation to all phenomena. The implication of this is that reality cannot be known through separation and isolation of phenomena from the whole of reality, but should rather be discovered, and it is through such discovering which reality is enfolded into a phenomena, and unfolded into the whole, within a context of infinite potential. For Bohm,

the relationships constituting the fundamental law are between the enfolded structures that interweave and interpenetrate each other, throughout the whole of space, rather than between the abstracted and separated forms that are manifest to the senses (and to our instruments) (2010[1980], 235).

Bohm recognised the incomplete nature of knowledge, and engaged in intercultural (Santos, 2004) dialogues with a number of scholars from epistemological traditions beyond western science (most famous among these were his interactions with Jiddu Krishnamurthi, and, through collaboration with his colleague, David Peat, a number of Blackfoot and aboriginal scholars such as Leroy Little Bear (Kainai⁴⁰) and Pam Colorado (Onenioté'á:ka) (Evering, 2011; Peat, 2005).

Bohm's work illustrates the potential for intercultural translation across Latour's 'second Great Divide' (1993), and Santos's *Abysses* (2004). Indeed, there are increasing works engaging in intercultural translation between quantum physics more broadly, and a range of other ontological articulations (see for example, Roy, 2015; Afilanlo & Schipper, 2012; Krishnamurti & Bohm, 1985; Mohrhoff, 2007; Duquette, 2011). However, while Bohm's work provides a powerful leverage point for intercultural translation between the western sciences and other epistemologies, it should also be noted that Bohm maintained an essentially Eurocentric, rationalist and modernist view of the world. While he enthusiastically engaged with a range of indigenous scholars during the latter part of his life, it is evident in his writing that he did so from a position of Eurocentric superiority (see for example, critiques from Evering, 2011). Similarly, although he dedicated time to reclaiming artistic, emotional and intuitive knowledges, he ultimately foregrounded the mind as the generator of knowledge, counter to many other relational epistemologies.

40 True names of these renowned scholars were sourced from my Indigenous Studies colleague, Brigitte Evering, without whom I would have been careless enough to limit my reference to common names.

3.2.4.4. Generative openings offered by quantum physics

Summarising key disruptions in classical, dualistic accounts of reality, Griffiths purports that,

Quantum mechanics is clearly superior to classical mechanics for the description of microscopic phenomena, and in principle works equally well for macroscopic phenomena. Hence it is at least plausible that the mathematical and logical structure of quantum mechanics better reflect physical reality than do their classical counter parts. If this reasoning is accepted, quantum theory requires various changes in our view of physical reality relative to what was widely accepted before the quantum era, among them the following:

1. Physical objects never possess a completely precise position or momentum.
2. The fundamental dynamical laws of physics are stochastic and not deterministic, so from the present state of the world one cannot infer a unique future (or past) course of events.
3. The principle of unicity does not hold: there is not a unique exhaustive description of a physical system or a physical process. Instead, reality is such that it can be described in various alternative, incompatible ways, using descriptions which cannot be combined or compared.

All of these, and especially the third, represent radical revisions of the pre-quantum view of physical reality based upon, or at least closely allied to classical mechanics (Griffiths, 2002:368).

Bohm's work goes further than the divisions and incoherences between mainstream and quantum physics, towards reconciliation between them. Bohm and Peat (2000:293-294) point out that,

Despite over half a century of activity on the part of theoretical physicists, relativity and quantum theory have not been unified, ... into a single coherent theory. Clearly what is at stake is not some new idea or novel theory but an approach that addresses the tensions and conflicts within the orders of quantum theory and relativity. A deeper order is needed, one that contains the orders of both these theories as special cases.

Quantum physics offers experiential accuracy, and simultaneous resistance to generalisation, while foregrounding the relational nature of a contingent reality. It thereby generates some ontological common ground through which to engage in collective conversations about the nature of reality across both 'Great Divides' (Latour, 1993) or 'Abysses' (Santos, 2004).

3.2.4.5. A caution against hasty inter-cultural translation

Many scholars have been critiqued for over-extending the ontological opportunities emerging from quantum physics, and ultimately mis-understanding and abusing the field to validate beyond-scientific forms of knowledge. Such critique seems to arise from scientists who have little understanding of the ontological positions of such knowledge forms. The misunderstanding, from what I have perceived is this: If one is making the claim that quantum physics validates the ontologies of particular indigenous or other-than-scientific knowledges, then this claim is inaccurate.

From my understanding, quantum physics does not validate indigenous or other-than-scientific knowledge forms. Instead, it indicates an expansion within *modernist western scientific* thinking, which enables *western science and the spokespersons of such science*, to better begin to engage in inter-cultural translation (Santos, 2004, also see 2.11.4) with other knowledge forms. In other words, it provides for the *western sciences* an ontological, and conceptual frame from which to engage with other knowledges, without imposing a material-realist ontology onto them, or delegitimizing them on such ontological grounds. However, it should be noted that quantum physics still uses as the basis of its rationality, a realist conception of reality. Quantum physics has enabled the expansion of this into a multi-dimensional perspective, but its starting point remains (for now), empirical reality. This is why much of quantum physics is still delegated to an idealist domain - theoretical but as yet unsubstantiated empirically.

Vedanta, Kabbalah, and other what might be termed 'indigenous' or 'alternative' schools of thought, on the other hand, all seem somewhat aligned in that they take as their starting point, the subtle and connected energy of creation, which in some enactments only, materialise into physical (and therefore empirically perceivable) reality. This perspective resonates more strongly with Bohm's implicate and explicate orders. So quantum physics is working with, for example, what might be considered a notion of *Akasha* (Vedic), as it enables materialisation of physical and empirically perceivable matter or substance. But Vedanta works with *Akasha* both physically and meta-physically or subtly. *Akasha* is that all-pervasive creative force which holds the initiate potential for enacting diverse subtle and gross forms of creation. Yes, it aligns with the vibrational wave nature described in quantum physics, but to say that *akasha* is the same as the notion of flux is to diminish what *akasha* is, because the Vedic understanding of *akasha* goes beyond the quantum physics understanding of flux. Kabbalarians caution against a similar danger of conflation between concepts, highlighting Santos's concerns when engaging in epistemological inter-cultural translation (2004; also see 2.11.4). For resonating critiques, see for example, Evering, 2011; Afilanlo & Schipper, 2012; Mohrhoff, 2007; and Duquette, 2011. Instead of claiming that quantum physics validates any other knowledge form, it would be more accurate to say that western science has begun to achieve some measure of coherence and validity from the perspective of these other knowledge forms. Science is approaching a level of insight and understanding which enables it to begin to engage in onto-epistemic exchange with these examples of alternative knowledge forms.

Both Latour's *New Constitution* (1993) and the field of quantum physics provide opportunities for generating a more coherent ontological frame for epistemic activity within the western sciences. They provide onto-epistemic opportunities to (re)discover, (re)define, and (re)constitute a more coherent ontological account of reality in ways that directly seek to address Latour's *Divides* (1993), and Santo's *Abysses* (2004). Both maintain the empirically generated epistemologies of western science, while also working to dismantle the dualism at the heart of *Divides* and *Abysses*.

3.2.5. Relevance to Epistemic Activity in the Field of Citizen Science

As noted in the introduction, the field of citizen science uses scientific knowledge as the primary basis of legitimation for evaluating epistemic contributions and building common knowledge. Jones (2010) points out that Cartesian assumptions generally function in ways that are unrecognised, or just as frequently denied. To begin understanding their impact, we need both to reflect on current social practices and historically trace and situate the emergence of key ideas which have contributed to our culture. Chapter 2 provides a more substantive theoretical argument for the limitations of this approach to legitimation, and the three data chapters (5, 6 and 7) demonstrate the limitation of this form of epistemic legitimation in relation to epistemic enactments in the field of practice. Together, Chapters 5, 6, and 7 demonstrate the need for a more expansive and generative system of legitimation, which enables and accounts for stronger epistemic justice.

While I engage three particular critiques of dualism within this chapter at a more general and theoretical level, I crystallise (Ellingson, 2009) these arguments through the critiques emerging through practice as more specific, contextual manifestations of the general arguments presented here. For clarity's sake, what is in reality one continuous argument, has been spread out across the three critiques presented in this chapter. Each develops and deepens an understanding of ontological assumptions and axiological charging incumbent to dualism, and within the contexts of the specific arguments being made in each line of critique. This critique provides a starting point as it begins the work of making implicit mediational role of dualistic sorting visible. The next critique considers the role of mediating institutions, and the ways in which they shape, privilege, and denigrate particular types of epistemic activity.

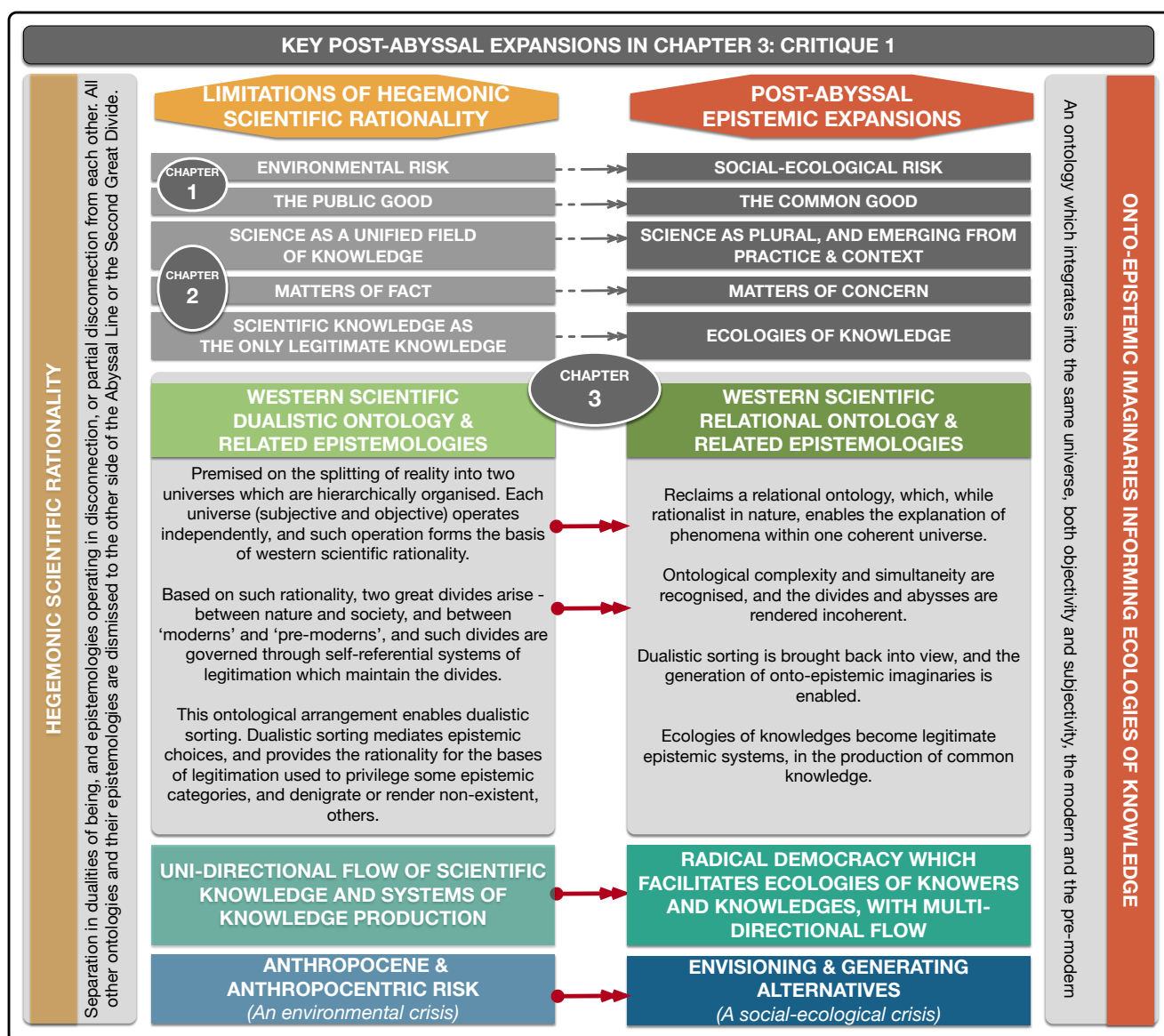


Figure 13: Visual summary of post-abyssal expansions in Critique 1

Critique 2:
Science and its Publics:
A Critique of Knowledge Flow

3.3. Science and its Publics: A Critique of Knowledge Flow

As long as abyssal lines go on being drawn, the struggle for cognitive justice will not be successful if it is based solely on the idea of a more equitable distribution of scientific knowledge. Apart from the fact that an equitable distribution is impossible under conditions of capitalism and colonialism, scientific knowledge has intrinsic limits in relation to the type of real-work intervention it makes possible (Santos, 2007:13).

The relationships between science and its publics⁴¹ are most often mediated through policy mechanisms and systems. Visvanathan (2006:166) points out that,

[m]odern development was a process of nation-building. It was predicated on a social contract between science and the nation-state to guarantee national security and promote development. Its grammar was embodied in the model of transfer of technology from metropolis to periphery, a sequence that involved a movement from invention and innovation to development.

Historically, these relationships have been mediated through a diverse range of approaches, and enacted through their individual epistemic cultures. In this section, I intend to articulate some of the significant contours of the arguments concerning the relationships between science and its diverse publics. My intention is to provide an overview of key debates relevant to citizen science, rather than an exhaustive analysis of a large and contentious arena of research; therefore, my focus is on articulating knowledge relationships, intentions and tensions, rather than providing a systematic literature review of this domain of research.

My central concern is an articulation of the systems of science-policy-public interactions and their implications for general knowledge cultures - especially as concerns an interest in knowledge production for the common good in response to social-ecological risk. Citizen science knowledge practices are shaped, enabled, or foreclosed, based on whether the institutional structures facilitating science-policy-public interactions are able to accommodate them (see for example, Lotz-Sisitka, Vallabh & Madiba, 2019; and the case studies presented in Chapter 7). The current shape of science-policy-public pathways determine the extent to which citizen science can be implemented, the efficacy of contribution to national risk management processes, and recognition afforded to the knowledge being produced within such initiatives. The below articulations are, of necessity, summarised and incomplete, and simply pull forward key threads from a broad domain of research.

⁴¹ I wrote an earlier version of this critique of science and its publics, included as part of an unpublished report in Lotz-Sisitka *et. al*, 2019. This report, which is a collective project among a range of citizen science researchers, is included as Appendix 9. It provides a South African illustration of the policy environment in relation to water-based citizen science. The review illustrates how the arguments in this section manifest and play out within an enacted setting.

I begin by summarising a range of dominant models of civic science. I then outline arguments for challenging notions of scientific citizenship and the purposes for developing scientific literacy. Next, I consider the notion of 'the public' and the constitution of such a public, before articulating a plural and pluriversal system of legitimation when working with scientific knowledge within the science-policy-public system of activity (which is where citizen science practice is located). Thereafter, I highlight debates about when, how and why publics are engaged in deliberative processes concerning techno-science, before considering in greater depth, the mediational role of policy systems which manage and facilitate interactions between science and its publics. Within each of these sub-sections, I work to generate invitations into more expansive and just onto-epistemic imaginaries. I end the section with an overview of these imaginaries, and how they might better enable knowledge production in response to social-ecological risk, and towards safeguarding the common good.

3.3.1. Models of Civic and Citizen Science

Internationally, two main fields of research have contributed to investigating and articulating science-policy-public relationships (Leach & Scoones, 2005), including the fields of:

- Science and Technology Studies (STS), theorising work within the global North; and
- Development Studies (DS), arising in and theorising work emerging within the global South.

STS initially focused on legitimising the success of science to publics through policy mechanisms and mediatory institutions, but later also engaged in challenging the assumptions and practices of science. Comparatively, DS emerged through a stronger focus on practice-based engagements between science, and public and local knowledges, and their socio-cultural underpinnings (Leach & Scoones, 2005). Each of these fields have contributed a diverse range of perspectives to the debate, and form the basis for civic and citizen sciences.

Broadly speaking, the term 'civic science' is used to describe the range of approaches encompassing notions of civil, participatory, democratic, and stakeholder education and science, among other terms used to describe science-public interactions. The term 'civic scientist' refers to a scientist who engages in science education and communication with members of a public. This includes a range of approaches encompassing increasing science awareness or building science knowledge and skills, through to facilitating discussions and/or engaging the public in processes of decision-making on the contributions of science to issues of

social significance. Traditionally, civic scientists were distinguished from members of lay publics, and held an authoritative position as experts who supported the public to understand why they, as spokespersons for science, should be trusted to make scientific decisions on behalf of the public. This perspective has begun to shift radically in some spaces, but remains entrenched in others. The notion of a civic scientist is in stark contrast to notions of citizen scientist, which instead describe members of lay and expert publics who collectively engage in scientific knowledge production together; I return to this area of practice at the end of this sub-section.

Each approach to civic science is characterised by, and enacted through particular institutional, normative and epistemological positions that predispose them to particular epistemic cultures and practices. Issues of participation, representation, legitimacy, institutional culture, transparency and policy intention remain under-researched and/or contentious within many approaches to civic science. Bäckstrand (2003:24) suggests that the concept of civic science,

alludes to a changing relationship between science, expert knowledge and citizens in democratic societies. In this perspective, citizens and the public have a stake in the science-politics interface, which can no longer be viewed as an exclusive domain for scientific experts and policy-makers only.

She argues that the participatory turn in science-policy-public interactions can be interpreted as a form of resistance to the 'perceived scientisation of politics', which are based on the assumption that social and political issues are better resolved through technical-scientific forms of expertise, than through deliberative democratic processes (Bäckstrand, 2003). Here, citizens are framed as more-than-recipients of scientific expertise, and are rather viewed as democratic actors within science-policy nexes (*ibid*). Democratic mechanisms enabling publics to engage with and within the science-policy nexes are grounded on a perspective that scientific knowledge forms a public good, and that how such knowledge is taken up into the public sphere through policy processes is a matter for democratic deliberation and engagement (*ibid*).

Civic science activities, however, need to be viewed through their attendant theoretical, institutional, normative and epistemological positions, which substantively differentiate the range of activities encompassed by the term (Bäckstrand, 2003). Issues of participation, representation, legitimacy, policy intention, institutional culture, and transparency remain challenging within many civic science approaches, often perpetuating notions of deliberative and participatory democracy with what are instead, simply participatory models for bureaucratic compliance or policy-enabled systems of consumerism (see, for example critiques leveraged by

Árnason, 2013; Bickerstaff et al.⁴², 2010; Felt et al., 2009; Bäckstrand, 2003; Irwin, 2001; Wayne, 1992). Notions of democracy and related mechanisms for deliberative or participatory democracy also tend to be confined to contexts of domestic policy-making (Bäckstrand, 2003), in spite of global contexts of knowledge production, and borderless social-ecological risks. Four main iterations of civic science dominate the literature, each is discussed below.

3.3.1.1. Deficit models of science education and scientific literacy

Here, citizens are framed as deficient in their understanding of science, and in need of scientific literacy development. This heavily critiqued model often frames citizens as overly emotive due to a lack of rational understanding of the principles of scientific work. Within deficit models, civic science is considered successful when lay publics come to hold similar opinions to those held by scientific experts. Key strategies within such models focus on developing science education and literacy development programmes which seek to rectify this deficiency by providing citizens with correct scientific facts and explicating why such facts are trustworthy and reliable (for critiques, see for example, Árnason, 2013; Hess, 2011; Bickerstaff et al., 2010; Felt et al., 2009; Bäckstrand, 2003; Elam & Bertilsson⁴³, 2003; Irwin, 2001).

3.3.1.2. Citizen-consumer models

Citizen-consumer approaches are concerned with convincing citizens of the economic values of techno-scientific innovations, and mediating concerns over risk in light of such values (see, for example, Bickerstaff et al., 2010; Rose & Novas, 2004; Elam & Bertilsson, 2003; Irwin, 2001). This is often done retrospectively, arguing that large economic and skills investments have already been made into a particular research project or intervention, accounting backwards and foregrounding any privatised obligations that have become implicated in the research project or intervention politics associated with a research. Within these models, the aim is to establish scientifically informed publics which are willing and able to make consumer decisions with incomplete scientific information, within contexts of unknowable complexity. Such models leverage mechanisms of deliberative democracy towards privileging economic rationalities related to research investments and the establishment of new innovation-related markets, rather

42 Bickerstaff, K., Lorenzoni, I., Jones, M., & Pidgeon, N.

43 While this paper provides a useful overview of the various models of civic science, as well as some interesting critiques, it also includes a number of assumptions which contradict with the broader arguments in this section, and in the thesis more broadly, foremost among which is the positioning of science in a hierarchically superior position to other forms of knowledge.

than public or common good outcomes. Halkier (2017) raises a concern that public communication strategies engaging this framing tend to address citizens (and non-citizens) as private consumers, rather than members of a public, thereby contributing to a form of privatisation and individualisation of a particular science-public issue, and thus translating a matter requiring public input into a drive for changing consumption patterns instead. Elam and Bertilsson (2003:240) point out that in such approaches,

... the suspicion remains that those responsible for designing new public forums are ultimately doing so for their own purposes: that public experiments in the new democratic governance of science are ultimately more akin to highly sophisticated exercises in social or market research.

3.3.1.3. *Deliberative democracy models*

Such approaches emphasise deliberation and dialogue between publics and scientists and, in theory, act as democracy-enhancing mechanisms. The intention here is for the public to represent itself through mediated deliberative processes, and through such deliberation, develop consensus regarding techno-scientific interventions, innovations and risks. Opportunities are afforded for knowledge to flow both ways between scientists and publics.

At the more conservative end, such processes are seen as more strongly participatory processes for allowing publics to express concerns and values related to particular issues, while providing a more engaged process of public education (see some arguments in Árnason, 2013).

Elam and Bertilsson (2003) describe two approaches to deliberative democracy:

- a) A shallow approach where deliberation focuses on the legitimacy of a particular research program, and ends once there is consensus regarding legitimacy - this form of deliberative democracy is in service to representative democracy; or
- b) A deeper approach where deliberation is related to seeking authorisation for innovative actions, and is seen as the beginning point of public engagement, rather than an end-point, opening up towards the potential for knowledge co-production between science and society.

Irwin (2001) reflects on the limitations of such models, arguing that they can sometimes resemble participatory extensions of more corporate models of governance. However, in theory, this model concedes that scientific knowledge is not always primary, and that sometimes other considerations and/or knowledges might take precedent or might moderate techno-scientific knowledges. As Felt *et al.* (2009:355) distinguish, "the public is no longer seen as a passive entity to be convinced by the superior rationality of science ... [r]ather it is imagined as carrying

its own legitimate values and opinions towards science". Authentic models of deliberative democracy require us to ask whether the "mechanisms of public deliberation" (Irwin, 2001:2) are able to keep the promises implied in the slogans of public engagement and empowerment or *whether they serve other purposes*" (Árnason, 2013:934, my emphasis). The caution here is that deliberative democracy models (which aim to facilitate stronger, more reasoned democratic decisions) should not be conflated with more direct models of participatory democracy, which are concerned with widening the scope, depth and number of issues about which citizens have direct say and are able to take direct action about; nor should they be viewed as inherently democratic on the basis of their more participatory mechanisms. Árnason notes that conceptions of deliberative democracy are based on notions of rationality and reason as primary mediators of decisions. A key challenge in engaging deliberative practices is in countering institutional understandings of science-lay public relationships (Petts & Brooks, 2006). This opens up questions about the divergent bases of legitimation between scientific, policy and lay knowledges and their attendant bases of legitimation, which I engage with in Appendix 11.

Two strong critiques of deliberative democratic approaches include a skeptical and a liberal critique (Árnason, 2013). The skeptical critique raises concerns about the potential for deliberative processes to reinforce existing power relations while reducing other spaces for dissent against techno-scientific innovation and associated risks (Elam & Bertilsson, 2003), as well as perpetuating a view of a homogenised public who represent consensus on behalf of society as a whole, without the need to engage substantively with other dissenting positions or absent publics (Árnason, 2013). Liberal approaches to deliberative democracy foreground the rights of individuals over collective publics and resist 'illegitimate intrusion' into the private sphere. This stance defends that individuals should be able to represent their own interests and views, rather than collective, common or public goods and perspectives. Árnason (2013) notes that this argument makes it possible to reap techno-scientific benefits without public 'interference', and reduces democratic resistance to policy implementation systems while encouraging more passive formations of citizenship. Instead, Árnason (2013:934) argues that a,

deliberative vision of the scientific citizen does not violate the right to privacy and freedom from politics but it emphasizes the fact that in democratic society every citizen is partially responsible for public policy,

and that the State bears responsibly for enabling and supporting the public to assume their democratic responsibilities. For articulations and critiques of deliberative democracy models, see discussions by Árnason, 2013; Hess, 2011; Bickerstaff et al., 2010; Felt et al., 2009;

Bäckstrand, 2003; Elam & Bertilsson, 2003; and Irwin, 2001. A stronger approach to deliberative democracy models is to move beyond limited notions of equality, where every viewpoint is accorded equal weight, and instead, to engage in reflexive deliberation through presenting multiple perspectives, priorities, and ethical considerations. Communication, and more significantly, knowledge, flows in multiple directions, rather than from scientific experts towards lay publics, as seen in deficit and consumerist models of science education.

3.3.1.4. Participatory, radical and pluralistic democracy models

Such approaches seek to develop the foundations of deliberation, and extend towards engaging publics in processes of co-governance. Both consensus and contestation are valued, as are multiple forms of knowledge. There is an interaction between universal knowledge and local specificities, and democratic deliberation arises through embracing the tensions between these, and ideologically and structurally rejects political practices which concentrate on one to the exclusion of the other. Participatory democracy is enabled through extending public involvement into implementation and ongoing engagement in innovation development and rollout, or with ongoing risk management and decision-making, for example. Radical and pluralistic democracy is enabled through publicly calling into question any established moral or epistemic authority claimed by researchers and institutions presiding over research, policy-making or policy translation processes (Elam & Bertilsson, 2003), and enabling ideological and structural systems which actively seek to engage alternate knowledges, perspectives and ethical positions in substantive ways. Callon (1999:89-90) suggests that in robust radical and pluriversal approaches, the dynamic of knowledge co-production,

is the result of a constantly renewed tension between the production of standardized and universal knowledge on the one hand, and the production of knowledge that takes into account the complexity of singular local situations, on the other hand. These two forms of knowledge are not totally incompatible ... nor are they produced independently from each other ...[instead]... they are a common by-product of a single process in which the different actors, both specialist and non-specialist, work in close collaboration.

3.3.1.5. Citizen science as an emerging edge

Drawing on theories of democracy, the models of civic science⁴⁴ described above articulate various approaches to engaging publics in deliberation about science and techno-scientific

44 There is some confusion around the term civic science, with authors such as Dillion *et al.*'s attempt to engage the term in relation to more 'transition-driven' forms of citizen science in relation to wicked problems (Dillion *et al.* 2016). In this thesis, I maintain the description of civic science for the approaches described in this section, and use citizen science for approaches where publics are engaged in scientific knowledge production, rather than engaging with knowledge already produced by scientists.

innovation and risk. An emerging edge of practice which shares some overlap with participatory, radical and pluriversal models of civic science is that of citizen science. Citizen science is concerned with directly involving publics in various forms of scientific knowledge production (see Vallabh *et al.*⁴⁵, 2016). Here, publics become *directly involved* in scientific knowledge co-production towards a range of goals, ranging from more simple approaches of data collection to more strongly co-engaged models of knowledge co-production, co-management and advocacy (*ibid*), and begin to engage in what Callon (2004) describes as contributory science. In Chapter 5, I engage with topographies of citizen science in greater detail, as part of a more extensive review of more recent perspectives.

3.3.2. Scientific Citizenship Against or As Commoning?

Notions of scientific citizenship have expanded as the field of civic science has, giving rise to a range of ideological and democratic tensions. Irwin (2001) provides an illustrative critique of formulations of scientific citizenship, with particular attention given to the significance of: a) institutional location; b) the balance between information and consultation; c) extent to which pre-framing of citizen consultation processes affect form and outcome of such processes; and d) the significance of underlying technical and social assumptions. His argument illustrates how the above directly and indirectly shape what is prioritised, privileged and foregrounded, for whose benefit and towards which political and social agendas (*ibid*). He also makes special note of a deficit approach towards public knowledge about scientific technologies and a tendency (in the cases illustrated in his paper), to separate out “hard facts” from “matters of judgement”; these combined produced a dualism which made it difficult for citizens to either argue back in scientific terms or seek alternative assessments to inform their inputs and stances (Irwin, 2001). In his reflection about the public consultation process reported on, one of his most telling statements was that,

[c]itizens played an important role in this initiative, and participated energetically, but their contribution was ultimately refracted though [sic] the research process. Certainly, the “citizen-led and participatory” aspect of the exercise was highly restrictive and suggestive of an indirect form of citizen engagement (Irwin, 2001:15).

This observation calls for more substantive review of the specifics of citizen participation, in terms of levels of participation, but also and importantly, in terms of purpose, role, forms and focus of participation through various stages of a public consultation process. Irwin suggests that it is necessary to adopt a flexible and situationally appropriate approach to civic science and the

45 Vallabh, P., Lotz-Sisitka, H., O'Donoghue, R. & Schudel, I.

construction of scientific citizenship, rather than seeing any one approach as a fixed and unchanging commitment, and that,

the relationship between science and democracy should not be about the search for universal solutions and institutional fixes, but rather the development of an open and critical discussion between researchers, policy makers, and citizens ... [and that we need to] ... explore the social processes, underlying assumptions and operational principles through which scientific citizenship is constructed in particular settings (2001:15-16).

Civic and citizen sciences inevitably include some form of activity geared towards developing the scientific literacy of publics in order to strengthen the publics' ability to engage coherently with science-policy structures. What scientific literacy entails, and how it is developed is linked to the particular notions of civic science that an institution or State embraces and seeks to promote. Which science or aspects of scientific culture a citizen needs to be literate about depends on the intentions of how we wish them to participate in, and interact with the scientific domain. For example, Wynne (1992b:42) argues that scientific literacy includes three related aspects of knowledge including: "the formal contents of scientific knowledge; the methods and processes of science; and its forms of institutional embedding, patronage, organization and control". He points out that more traditional models of civic science generally only focus on the first two, and often in simplistic forms; however, it is the third aspect of scientific literacy that is particularly significant because it engages the social dimension which permeates all experiences of, and responses to science (*ibid*). He further argues that this applies as strongly to scientists' representations of science because such representations are "shaped by tacit social assumptions or models of their audience, its needs and capabilities; and these social models are shaped *inter alia* by the institutional dimensions of science". Nowotny (1993)⁴⁶ points out that science and various publics are connected through complex webs of interactions, suggesting that scientific literacy should encompass such diverse and changeable interactions.

Adding to this, Árnason (2013) articulates a version of active citizenship which implies that citizens can be motivated, informed, and able to critically reflect on society, as well as willing and able to participate in processes of public deliberation related to matters of shared concern. He argues that institutions wishing to promote democratic processes of engagement between citizens, and science and technology research, and implementation strategies should be geared

⁴⁶ It should be noted that although Nowotny (1993) carefully maps out five sites of inter-relationships between science and publics, her perspective maintains an elevated view of science in relation to other knowledge forms in this paper. While her broader point is relevant to the arguments presented in this section, her interior assumptions maintain the power relations which this thesis seeks to challenge directly.

towards both developing such citizens, and also towards engaging with citizens in ways that promote authentic forms of deliberative (and I would add, radical and pluriversal) democracy, and which enable active citizenship. Rose and Novas (2004), and others argue for ethical self-formation promoted through political activism as a feature of active citizenship. However, Árnason (2013) cautions that ethical self-formation, and ethical reflection on common interests, are not quite the same thing. He argues,

[t]he former basically collectivizes individuals on the basis of their private interests and self-interested strategic action in order to have a political impact through force. The latter emphasizes deliberation which requires that participants assume a public standpoint from which they discuss matters of public policy. The former is built on the model of special interests power politics, the latter implies a vision of citizens who are ready to revise their preferences in light of good reasons and arguments related to common interests (*Ibid*:931)

His argument brings into sharp relief the distinction between private individuals defending their self-interests through strategic interactions, and democratic deliberation as a process of commoning, and as a form of active citizenship.

I am not arguing that citizens should not promote their self-interests as part of their democratic rights - rather, like Árnason, I argue that these two forms of participation and deliberation cannot be conflated with each other. Each requires a different system of support and enables markedly different social-ecological outcomes. In this thesis, I am more strongly concerned with understanding active citizenship and scientific literacy as it relates to commoning and the common good. Current models of civic (and citizen) science foreground public, and often private or privatised interests. How do the conceptions of scientific literacy and the role of civic science begin to shift when commoning and the common good are foregrounded, and the intention is focused on resolving social-ecological risk. The invitation here is to open up new onto-epistemic imaginaries for what might be implied by scientific citizenship as *commoning*.

3.3.3. A Diversity of Publics

In a democratic society, the relationship between science and society is mediated and translated through the elected State⁴⁷. With this representative mandate, the State functions on behalf of the public via its policies and policy implementation mechanisms, commitments and

⁴⁷ It may be argued that the state is not the only mediator between science and the public, and that there are a range of scientific institutions and independent actors who shape citizen engagements with scientists, it might also be argued that the entire system of science is implicated in state structures and policy systems, as well as in the funding systems which govern science-public interactions. However, a more careful investigation of other mediating institutions would be of benefit to gain a more careful understanding of how they are implicated (or not) in state-based forms of mediation. This is a gap in this particular review that I hope to pick up at a later date.

spokespersons. Via policy and policy implementation mechanisms, the State speaks for, and represents, the public and through this, defines the way in which the public might voice their interests regarding the conduct and impacts of science and technology. How the State comes to its representative positions and translates these into management strategies for various public resources is therefore significant. The ways in which notions of 'publics' are mobilised to inform State functioning determine which forms of representation are being supported and therefore impact on the overall democratic legitimacy that a State can claim - in other words, State legitimacy involves more than representation as determined via public elections.

To begin with it is useful to understand what the notion of 'public' excludes: notions of 'the public' include representatives of the human population of a nation state - there are no representative mechanisms for the rights of other species or the Earth Systems themselves, no representative obligations for the Earth as a whole⁴⁸, beyond what has been articulated into policy, often from a primarily Anthropocentric perspective (see Critique 3). While the other-than-human world might be represented by advocacy groups or individuals, they are limited to what is possible within existing policy, and the State itself has been mandated with this representative responsibility on behalf of all its citizens. Nation States are primarily mandated to represent citizens of that nation, although State unions do go some way towards extending this interest to neighbouring and affiliated Nation States. Finally, the primary focus for a State is current citizenship, rather than past or future generations - the State itself is mandated to play the representational role on their behalf, and so no special processes are included in public consultations for future generations. Many policy systems gesture towards an interest in managing resources on behalf of future generations, but in practice, current generations are prioritised for political (maintaining voter bases), economic (short-term economic development incentives), and social reasons. The notion of 'the public' then primarily includes representatives of the current human citizens of a Nation State.

The term 'the public' is often referred to in generalised ways, signifying 'not scientist' and 'not policy-maker or policy-implementor'. However, a generalised notion of 'the public' is misleading in that it can perpetuate the idea that there is one homogenous group of people (who are not scientists), with shared views, interests, priorities, challenges and risks. Felt *et al.* (2009:355)

⁴⁸ This is not an area I was able to pursue specifically in this section. I do touch on it in section 3.4, but not with the depth this area deserves.

argue that although the concept of public deliberation and consultation is integrated into increasing numbers of policy documents and mandates, it “largely remains unclear who concretely is to speak in the name of the society [or public]”. Hess adds that,

[t]he concept of a “public” with respect to science and technology sometimes is based on two assumptions: the public is composed of individuals (rather than organizations or even networks of organizations) who form opinions about science and technology; and the individuals are holders of lay knowledge in the sense that they lack the expertise of the particular science and technology in question, even if they hold occupational and local knowledge that may be relevant to assessing or interacting with scientific and technological expertise (2011:627).

Such framings of who and what the public is obscure the reality that there are always multiple publics, who are often differently impacted by techno-scientific risks, who have diverse priorities and needs, and who come together to form various groups and organisations to represent such unique positions. Nor does it recognise that publics include scientists and members with other forms of expertise, who are themselves engaged in scientific and other forms of knowledge work. Hess (2011) points out that we should recognise that publics can be and are constituted in multiple ways, towards particular outcomes.

In contrast to the notion of a homogenous public, Hess identifies four categories of publics, including what he describes as,

- a) Official publics, or those publics formally recognised and accessed by the State as representatives;
- b) Lay publics, who offer lay opinions when asked, such as through polls or market surveys, for example, who are researched for their levels of scientific knowledge, or lack thereof;
- c) Mobilised publics, relating to specific categories or groupings of publics that are mobilised towards particular outcomes; and
- d) Counterpublics, which are a type of mobilised public which aims to mobilise subordinate social positions which emerge in contestation of ‘official publics’.

Here, counterpublics stand in contrast to ‘official publics’, in that they are constructed by economic, political, or sometimes, intellectual and civil society elites. Both official and counterpublics are publics which are formed and mobilised through networks of organisations and individuals forming alignments between sectional interests and the general or public good, and who claim to speak on behalf of society as a whole, in terms of “what the public is, needs and should have” (2011:629). Hess argues that publics which are positioned as subordinate to

official publics are often also anchored in organisations, and have similar capacity to generate both interactional and contributory expertise (Collins, 2004), thus positioning them on par with the expertise of official scientific and technological communities (Hess, 2011). Additionally, Hess points out that many institutions engaged in deliberative processes of science-public interaction,

create a non-level playing field for the construction of the lay opinion public. By separating the lay opinion public from mobilized counterpublics, the lay opinion public is more easily aligned with official publics. Thus, some patterns of constructing deliberative institutions may do in practice what some STS researchers do in theory: participate in the construction of the public that separates out the claim to best represent the public that is voiced by counterpublic leaders (Hess, 2010:638).

He argues that official publics (those which are officially sought and whose participation is enabled through institutional systems) are often based on particular groupings of publics which are pre-selected to meet State functioning with most bureaucratic efficiency (*ibid*). However, other forms of public should also be accommodated within deliberation-enabling infrastructure, including for example, counterpublics composed of scientists occupying civic roles within NGOs and social groups, or mobilised subaltern⁴⁹ groups (*ibid*). At the same time, he warns against the danger of conflating the positions of mobilised networks of organisations and individuals who are able to form alignments between sectional interests and the general or public good, and who claim to speak on behalf of society as a whole, in terms of “what the public is, needs and should have” (Hess, 2011:629). Instead, he proposes that we adopt a perspective that,

... the public is not a single entity but composed of multiple publics, including those socially positioned in subaltern social categories; the boundaries between public and private are contestable, and hence the definition of what constitutes the public good or public discourse is included in public deliberation; and the boundaries between the public sphere and the state should not be presumed a priori but left open to analysis and contestation (Hess, 2011:629. Also see Asen & Brouwer, 2001; Warner, 2002 for expansions of this debate).

This perspective is supported by Mouffe (2000), who challenges the notion that democracy can ever be framed in terms of universal human equality, or that members of a public can authentically represent such a universal humanity, noting instead that representation can only ever be for ‘a people’, rather than all people. She argues that,

[c]onsensus in a liberal democratic society is - and always will be - the expression of a hegemony and the crystallization of power relations. The frontier that it establishes between what is and what is not legitimate is a political one, and for that reason, it should remain contestable. To deny the existence of such a moment of closure, or to present the frontier as dictated by rationality or

49 Antonio Gramsci (1971) coined the term subaltern to identify the social groups excluded and displaced from the socio-economic institutions of society in order to deny their political voices. The term is used here in this sense, to refer to those who remain marginalised in society.

morality, is to naturalize what should be perceived as a contingent and temporary hegemonic articulation of 'the people' through a particular regime of inclusion-exclusion (Mouffe, 2000:49)

Hess (2011) points out that just as scientists might claim that lay publics mis/understand science, the converse is also relevant - scientists too can mis/understand the knowledge claims arising from alternate knowledge forms and forms of reasoning. Similarly, the assumption that 'lay opinion public' is the referent for the constitution of publics, ignores the diverse forms of expertise, (including scientific expertise), which are located within for example, NGOs and other institutions positioning themselves as counterpublics. Researchers conducting science might, themselves, take up multiple positions simultaneously, engaging in research through formal scientific institutions while in service to or through enacting the agendas of diverse counterpublics. In recognising and reclaiming for scientists, a position within publics, both as holders of incomplete knowledges of their own, and also as potentially positioned within counterpublics, this expansion creates a more fertile and politically rigorous position from which to generate onto-epistemic imaginaries which enable knowledge production geared towards the common good, rather than towards State-mediated agendas based on scientific and State priorities. What Wynne (1992a, 2005), Hess (2011), Irwin (2001), Mouffe (1999), and others challenge through their arguments is the credibility, and therefore, legitimacy of official public alignments, mediated through official science-policy-public systems. Instead, they invite us to expand our onto-epistemic imaginations towards enacting alternative pathways and relationships between science and diverse publics, towards more robust and radically democratic collective goods.

Framing who represents public interests, and how they should be included within deliberative and participatory democratic engagements within the science-policy-public landscape then, requires ongoing reflexive engagement around people's concerns to authentically enable public participation. This does not deny the role or importance of the State, but requires that State actors co-engage with diverse publics around such concern, recognising that these may be contested, and this in turn requires an openness to policy interpretation, mediation and implementation in ways that may be different to the universalised assumptions that are often embedded in policy statements or intentions. It requires ongoing transparency about which publics are being engaged, and towards which ends, which publics have been excluded, and on what basis were they excluded, and how the State and other mediating institutions have and are dealing with dissenting voices, ethics, priorities and knowledges.

It is important to note an epistemic shift in the mediational role of the State and other institutions here: The original and perhaps more traditional role of civic science was aimed at engaging and convincing 'the public' that particular risks associated with techno-scientific innovations were acceptable and to the benefit of the public good. This included the development of basic forms of scientific literacy so that publics could engage meaningfully, and lent legitimacy to the representative role of the 'spokespersons of science'. It is important to recognise that such encounters were not necessarily detrimental to public wellbeing, or indeed, intended to undermine democratic process, and might well have enhanced democratic functioning and risk management within some (or even many) contexts. The re-imagined role proposed by many of the referenced authors, and through the wider arguments presented in this thesis reposition this role to one which intends to, and is designed to mediate between sometimes aligned, sometimes contesting knowledges, perspectives, ethics, public and common goods, and visions for the future. This repositions any mediation as firmly on behalf of heterogeneous publics, and reclaims the role of the State and State-mandated institutions and organisations as firmly in service to public and, preferably, as argued in this thesis, common goods. How would such notions be expanded if representation was extended to include the other-than-human world, future generations, and humans as diverse collectives? Favoured in this line of argument, are participatory, radical and pluriversal democracy systems - preferably working with all three related systems, for social-ecological justice and towards the common good. This would require consideration of institutional mandates, arrangements, and epistemic cultures, which I touch on briefly below.

3.3.4. Knowledge Relationships and their Bases of Legitimation

If the State and other mediating institutions are to play a positive role in mediating the interactions between diverse publics, science and policy generation and implementation mechanisms, then clarifying and strengthening relevant bases of legitimation⁵⁰ become a central concern. Garvin (2001:453) summarises four key assumptions within a normative understanding of science as knowledge maker, policy as knowledge mediator and manager of power, and public as receiver of knowledge and governance:

First, it assumes an uncomplicated and linear flow of facts and ideas from scientists to policy makers and then to the public. Second, this model infers differential power among the players. The knowledge producers (scientists) imply considerable power in the agenda-setting arena; the

⁵⁰ Differing bases of legitimation between knowledges are engaged with more specifically in Chapter 2 and 3.3.6. below, and are excluded from the discussions here.

knowledge users (policy makers) exercise less power as the transmitters and applicators of information; and the knowledge receivers (the public) are powerless and passive recipients. Third, this model assumes that each group acts in conjunction with its archetypal role and that practice reflects the idea. ... Finally, this model of policy making privileges knowledge and evidence and assumes that it has primary influence on the decision-making process. ... Reality is, in fact, much more complicated.

Instead of attempting to develop some sort of governing system of legitimation, Chambers (2003:208) challenges that we see accountability, rather than consent as “the conceptual core of legitimacy” within democratic contexts, because the substance, quality and rationality of arguments are core to whether such processes can be legitimately considered to be democratic. Latour (2004) and Santos (2004), respectively, argue that the ability to intervene into context be foregrounded as the basis of legitimation between diverse knowledges, and that there is a form of symbolic violence perpetrated when a dominant knowledge form projects its ontology and related bases of legitimation onto other subjugated knowledges (also see Law, 2004, and 2.9).

Adding strength to the arguments of Santos (2004) and Latour (2004), Garvin highlights the epistemological distances between scientists, policy makers and the public who, for Garvin, include the groups and individuals operating in the social world (2001). She demonstrates that each of the three groups and their related domains employ diverse forms of rationality in relation to scientific evidence, and employ different processes for generating knowledge about risky issues of concern. To begin with, Garvin challenges the clean classification of each group, recognising the artificial, polarised distinctions, homogenisation of in-group differences, and masking of between-group similarities (*ibid*). She also points out the mobility of individuals who enact diverse roles in different groups. Garvin suggests that categorisation and classification of people into different types of groups might best be seen as relating to how ideas are communicated, and on the shared objectives of any such group, and be treated as flexible and designed to meet a specific purpose within a complex and changing reality (*ibid*). In helping us to understand the epistemic distinctions between the three broad groupings, Garvin points out that individuals use different languages within each group setting, and each setting has its own discourses and agreed-upon conventions for identifying legitimate knowledge and formulating legitimate arguments for such knowledge (*ibid*).

Chapter 2 provides detailed arguments for the construction of ‘truths’ within the sciences, as well as processes for warranting and legitimating such truths, so those arguments have not been repeated here. Garvin (2001) describes the basis of legitimation within the policy landscape as

value-based and ethical in nature, and concerned with the mobilising of power. She describes the policy landscape in this way:

It is a negotiated process taking place in an area or “policy space” that defines a set of relationships between individuals and institutions. These negotiated relationships facilitate the development of consensus and, subsequently, policy action. The consequence is action based on underlying values. ... [E]ach issue’s policy space develops its own set of historical rules, values, and judgements that become embedded in the issue and are increasingly difficult to alter or revise over time. In most cases, once a policy issue is defined or framed in a particular manner, people and organisations operate within that frame to either reinforce the status quo or to rebel for change (*Ibid*:449).

Garvin notes that the process of participating in the issue, and accepting related knowledge and evidence constitutes a process of consensus-making; in this way, consensus definitions are granted legitimacy (*ibid*). Consensus here, can be described as an agreed-upon way of making sense or storying of the issue at hand, which gains prominence by being sanctioned by all visible players in the debate (*ibid*). Unlike in scientific contexts, knowledge construction within the policy domain is political in nature - it is an inter-related ‘mess’ of social, economic, political and ecological concerns, priorities, certainties and uncertainties. Each of these aspects, and the contextual realities arising out of them, have equal or greater bearing over what is considered acceptable and relevant knowledge, and whether such knowledge should or even can be enacted in response to risk (*ibid*). This shifts the process of judging the relevance and priority of evidence and information, and expands the domain of what might be considered evidence. Garvin points out that a key component of this domain are ‘risk industries’, whose sole function is the management of public concerns (and as an extension, public education) related to techno-scientific uncertainty and risk (*ibid*).

Publics work with knowledge in yet other ways. At a general level⁵¹, Garvin (2001) describes a public approach to knowledge as being deeply embedded in historical and cultural contexts. Although institutions within risk industries intend to manage risk on behalf of the public, the public also have their own bases of legitimation when evaluating knowledge and facts being presented to them. Where scientific experts might be seen to evaluate risk within the ‘technosphere’, public evaluations emerge in the ‘demosphere’, and are bounded by definitions of democracy and cultural rationality, which are experiential and historically contingent (*ibid*). Felt et al., (2009) and Wynne (1992a) similarly argue that publics might have substantially

⁵¹ The arguments in this critique, and this chapter more broadly, articulate the diverse nature of publics, and the risk of homogenising any characteristics related to those constituting a public. Garvin (2001) acknowledges the risk of such homogenising. The descriptions in this section are offered at a very broad and general level, recognising the need to engage with any one public in ways which take account of and enable their own unique configurations. The same can also be noted for scientists and policy-makers. Each field is dynamic and arises out of unique epistemic cultures.

different and diverse positionings towards techno-science and the questions and concerns associated with issues of risk and evidence of knowledge than scientists or policy makers, based on their situated perspectives, experiences and priorities. Information is derived and becomes interconnected through both formal and informal sources, including information offered by experts, personal experience, media, lay histories, and other ontologies and their epistemologies. However, this form of rationality is often discounted by experts.

Jasanoff et al.⁵² (1998) propose alternative bases of legitimation which publics might use to evaluate risk, in addition to techno-scientific facts: a) a lack of trust, b) irrelevance, and c) different models of agency. Trust relates to the credibility and perceived trustworthiness of the sources offering the information, and any understanding of the underlying motivations or interests of such groups. Trustworthiness might be related to whether a source has any experience within a particular risk context, what the institutional, political or cultural affiliation of an individual offering evidence might be and the historical relationships between that public and such institutions, for example (*ibid*). The legitimacy of knowledge claims based on professional expertise has become more and more questionable as complex risks have become manifest across diverse contexts. Knowledge might be deemed irrelevant when it fails to take account of or meaningfully contribute to the social and cultural realities of members of a public (Garvin, 2001). Finally, as relates to human agency, publics might dismiss evidence because they are simply not free to act on such evidence. Alternatively, acceptance of evidence might result in increased personal costs, destabilising of established lifestyles, dramatic shifts in income, etc. and such effects are evaluated in relation to any evidence. Garvin points out that for the public,

Science becomes just one of the many ways to view the problem and technical facts can be deemed less important than the social, cultural, economic, and political considerations that form the overall picture (2001:451).

The public, then, can be seen to both define risky issues suitable for public action, as well as incorporate knowledge beyond that formally produced by expert communities (*ibid*). Public knowledge can be viewed as adding to the body of personal experience which is used to revise and reformulate how people (as groups or individuals) understand their particular worlds (*ibid*). Garvin's conclusion is that each grouping defines, uses and legitimates evidence in diverse, although interconnected, ways (2001). Where scientific knowledge is specific and limited, and policy-makers knowledge is contextual, instrumental and applied to only the current context, the

52 Jasanoff, S., Wynne, B., Buttel, F., Charvolin, F., Edwards, P., Elzinga, A., Haas, P., Kwa, C., Lambright, W.H., Lynch, M. and Miller, C.

public's knowledge might be viewed as tacit, experiential and individual. Of course, scientists and policy makers are themselves members of various publics, and publics therefore also contribute to the membership of both techno-scientific expertise and the policy arena. The distinction then, is not about groups of people, but rather the epistemic cultures that individuals and groups might take up in different roles, and in light of diverse concerns or priorities. The projection of one set of legitimating criteria into another domain inevitably leads to conflict.

3.3.5. When, How and Why Publics Are Engaged: Ethics as a Mediating Tension

Science-public intersections converge most often around issues of potentially conflicting ethics; therefore ethics can be seen to play a mediating role through which such relationships are negotiated. Authors⁵³ such as Árnason (2013), Felt *et al.*, (2009), Wynne (1992a), Novas and Rose (2004), and Irwin (2001) point out that most often spaces for deliberative public participation, or even more straight forward processes of public participation, occur at the point just before, during or even after a new technology or innovation has been taken to market. This positions publics in contexts where they are only able to comment on, deliberate on, contribute to, or protest the uptake of knowledge or implementation of policy decisions which are already in-process. In other words, the processes come at a point when large investments have already been made in research and development around such innovations, and when market-related rationalities are foregrounded within both return on investment arguments, and related to the opening of new markets—therefore economic arguments are unduly prominent because of the timing of such engagements, as are private good arguments related to private investments into research, patents, etc.

Had such public-science deliberations been held at an early phase of research (say while the research was being conceptualised, or when early research findings became available), the basis of deliberation might have enabled more substantive focus on, for example, the common good as the basis for deliberation (Felt *et al.*, 2009). Felt *et al.* note, “instead of opening up more fundamental questions related to basic values such as “[d]o we need such an innovation?” or “[w]hat kind of society is implied in the visions this innovation carries?”, the issue may be narrowed down to questions of risk and safety” (2009:356, my emphasis). Law (2004) stresses that both empirical research methods and the design of public engagement processes need to

⁵³ These are some of the key references that were building the field at that time in this space. There has been a proliferation of work since then, some of which is reviewed in more depth in Chapter 5.

be considered because both perform and represent, as well as forward, particular visions of social realities and their underpinning ethical norms. Summarising a range of debates from the field of STS, Felt et al. (2009:357), argue that,

this sharp distinction between facts and values must be seen as problematic at best: facts are shown as fabricated (Knorr-Cetina, 1981), social values play a key role in how scientific facts and technological artifacts are shaped (Pinch and Bijker, 1984) and visions and versions of social orders are inscribed in these facts and artifacts (Latour, 1991, 1992). Further, it often is precisely these “facts,” the way they may be conceptualized and the values associated with them which are at the heart of public controversies on technoscience (Limoges, 1993). As evidently this also holds for social scientists producing “facts” on social realities, to assume the division between facts and values described above seems highly questionable.

Felt et al. (2009) identify three ‘closure mechanisms’ that emerged as obstacles to public engagement in scientific debates from an ethical perspective. The three closure mechanisms are articulated through three groups of discourse strategies, including what they described as:

- a) ‘Facts meet values’ - through which they described how knowledge hierarchies were mobilised to counter value arguments through reference to scientific data, where “a problem could be reframed in such a way that ethically motivated doubts had no place anymore” (2009:360). Within this hierarchy, facts (derived through scientific knowledge) were placed above values and other forms of knowledge. This first category illustrated that,

[t]o know the “right” facts seemed to be essential to re-direct the discussion of ethical questions. Both laypeople and scientists seemed to have internalized the model that facts are a better argumentative resource than mere values. The scientists were able to close ethical debates by either mobilizing values hidden behind hard facts as well as professional knowledge or by discursively changing the frame of reference for a problem (2009:362).

- b) ‘Displacement strategies’ - where both scientists and lay participants attempted to shift ethical questions to either institutionalised forms of expertise, or displace them through shifting frames of reference or ‘more appropriate’ timing (such as before implementation, or during trial periods). An interesting observation here was that areas that were ethically contentious but regulated through legal or institutional frameworks were seen (mostly by scientists) as unproblematic and therefore beyond of what was debatable with lay people. This conflation allowed the reduction of complex and multi-layered problems to be simplified in ways that streamlined scientific processes, while deferring ethical complexity to external regulatory mechanisms. Distinctions between ‘pure’ (and therefore ethically ‘safe’) research and applied research, reference to why and how research was being funded, and displacing ethical concerns to implementation aspects of research, all provided displacement opportunities;

c) '*Ethical questions as absent presences*' - through which they attempted to make visible the selective ways in which different groups (scientists or lay participants, in separate groups) were able to discuss certain ethical concerns within smaller groups that they were unwilling to voice in combined plenary sessions. The notion of 'absent presences' is borrowed from Law (2004), and used to indicate those ethical concerns which are present in particular forms or contexts, but not explicitly addressed within ethical dialogue between scientists and lay people. This was evidenced through the non-use of the term ethics to make fundamentally ethical arguments, with two key consequences highlighted by Felt et al. (2009:366),

first, by using different terminologies for debating the same issues it was possible to treat each of these discussions as an independent single event and not to see the dense network of ethical arguments that were present. Secondly, "ethics" somehow remained in a space apart, not tied into and linked with wider societal expert-led debates on ethics.

Felt et al. (2009) provide us with an interesting perspective into the limitations of deliberative processes between scientists and publics, where any democratic intentions could be undermined by the strategies highlighted above. They conclude that,

[a]s long as linear innovation models remain the basis of discussion, as long as scientific knowledge is automatically accepted as superior to any value position and as long as simple regulations are longed for as a central aim, participatory processes concerning ethical issues might quickly reach their limits (Felt et al., 2009:369).

If ethics are to be the mediator between science (whose spokespersons are scientists) and its publics, then their argument illustrates the need for more rigorous processes for mediating such dialogues through processes which provide robust, equal footing for ethical concerns in relation to facts, and alternative knowledges in relation to scientific knowledge, in order to enable such mediation to be effective. This argument was presented in more depth in Chapter 2. These authors' collective concerns point to a need to strengthen public institutions through systems which address the dualism of facts and values in ways which enhance and value ethical and values-based deliberation, and which enable the engagement of such forms of deliberation in conjunction with scientific and policy administration arguments. Again, the invitation is to consider how the dualism between scientific facts and values, the resulting relationships between science and its publics might be reconfigured by foregrounding an interest in the common good, and by engaging in such interactions as forms of commoning. In the next section, I review debates around institutional cultures more specifically.

3.3.6. The Mediatlional Role of Science-Policy-Public Systems: Cultural

Contradictions and Epistemic Cultures

The most established formal relationships between science and publics are mediated through national governance structures and their affiliated institutional systems. Through their structures and epistemic cultures, institutions facilitating public interactions with science provide the channels and mechanisms through which publics are enabled, allowed, or blocked from particular forms of deliberation and participation. Within such arrangements, State and State-funded institutions mediate and consolidate the voice of the public(s) in interactions with scientific bodies and their related policy systems, and play a similar mediatlional role for science, and their representation to publics. Therefore, they can be seen to enact both a mediatlional and gatekeeping function between science and the public, and thereby determine how policy is translated and enacted into practice. Currently, those science-policy-public interactions which are directed through formally recognised State governance apparatus are privileged, while at the same time, making it more difficult for other forms of interaction to be recognised as legitimate. There is a naturalisation of this role, alongside a lopsided allocation of resources and support systems to enable such pathways of interaction. The assumption is that the State is best suited to represent the public interest, and therefore mediate the translation of science into public systems. For example, while new institutional configurations are slowly beginning to emerge to accommodate citizen science approaches, there is still strong reliance on established policy-implementation institutions to enable and facilitate science-public engagements through citizen science. These institutions are called on to expand and transform their practices in order to be able to integrate, accommodate and promote authentic and effective forms of citizen science as novel mechanisms for enhancing participatory and radical models of democracy.

Árnason (2013), Wayne (2005) and Felt *et al.* (2009) highlight a range of reasons for why processes of public engagement in scientific and technological decision-making might be pursued, including promoting legitimacy of collective decisions; encouraging public perspectives on issues impacting a public; increasing visibility and accountability of policy processes; and increasing public confidence and trust in science and scientific expertise. As illustrated above, scientists or policy implementors representing techno-scientific innovations to the public, and who in turn, take decisions on behalf of various publics, are not necessarily neutral, unbiased or even acting in the best interests of either common or public goods. Garvin

(2001) describes three approaches to science-related State administration, which have come to dominate in industrialised and democratic nations especially. These include what she describes as rational policy making (also called the rational actor paradigm), politically and institutionally contextualised policy approaches, and finally, participatory, pluriversal policy development⁵⁴.

In a rationalised policy-making approach, knowledge is idealised and seen as superior to politics in the context of policy development resulting in knowledge abstracted from context; public policy bypasses spatial, temporal, and cultural differences and is perceived as being universally applicable. Problems and risks are resolved (or there is at least the attempt to resolve them) through the orderly administration of objective knowledge (*ibid*). The approach is underscored by and re-enforces the idea of linear, rational human activity as normative characteristics of modernity and progress (*ibid*). Complex social-ecological risks are often reduced to scientific problems, and seen to require either better application of established science, or more and better science to inform further action (*ibid*). The second approach of contextualised policy is more descriptive in nature, and frames power as more important than knowledge. This approach is characterised by a notion of knowledge as acquired, adapted and applied within highly political contexts. The approach foregrounds a more reflexive and incremental approach to policy development and implementation which is intended to be responsive to institutional contexts (*ibid*). One of the key weaknesses of such an approach is that policy makers end up creating and implementing small, short-term, and often short-sighted decisions (often by foregrounding self-interest) - immediate problems appear to be resolved, but fail to address long-term implications arising from the decision-making processes, and accountability structures remain under-developed and poorly enforced (*ibid*).

In contrast, participatory, pluriversal approaches, in theory, incorporate a diversity of views and are more participatory in nature. Such approaches aim to balance knowledge and politics, foregrounding their possible contributions in the context of specific realities being experienced by particular groups of citizens (*ibid*). These approaches attempt to strengthen accountability and context-responsiveness, focusing on purposive action and the applied nature of policy-making and implementation. Garvin (2001:448) summarises that the,

changing “faces” of policy analysis each delineates a different role for knowledge in policy. In the first approach, knowledge is scientific and closely linked to traditional, idealised conceptions of

⁵⁴ This last descriptor is my own interpretation of what Garvin (2001) is attempting to describe through this third approach - because she has not provided a label, I have chosen one which coheres with the arguments presented in the thesis.

truth seeking for objective facts. It is linked to rationality and modernism. In the second approach, knowledge is relative, partial, and used to sanction the use (and, sometimes, abuse) of power. This approach includes the inference that knowledge is a tool used by policy makers as the capricious means to a political end. In the third approach, knowledge is contextual and instrumental - knowledge is accepted as being partial and becomes one of many tools to validate socially acceptable policy options rather than an immutable, extant truth or a pawn in a power struggle.

Bickerstaff *et al.* (2010) note that the outcomes of public-science engagements are directly related to the values, practices and imperatives (or what they term institutional rationalities) of both commissioning and convening organisations. For this reason, they contend that this area of focus is underdeveloped, while the related democratic implications of such influences are significant (*ibid*). More specifically, Árnason (2013) suggests that not enough focus has been placed on the ability, appropriateness, trustworthiness and accountability of democratic institutions in facilitating and safe-guarding public participation in democratic machineries between science and its publics. He adds that institutions of governance provide the quality and conditions, contexts and directions, for enabling or hindering democratically legitimate processes, but that many such institutions are designed first and foremost as mechanisms for facilitating the exchange between scientists and policy-makers and implementers, to the exclusion of publics (*ibid*; also see Bäckstrand, 2003). It is only more recently that such institutions have sought to amend their functions to enable participatory public consultation and governance processes resulting in several ideological tensions and implementation challenges.

In response, Bickerstaff *et al.* (2010), Chambers (2003), Felt *et al.* (2009), Árnason (2013), Wayne (2005) and others all argue, first, for the need to interrogate alignment between institutional cultures and mechanisms for authentic democratic participation, and second, to engage in sustained processes of cultural transformation to enable the change of institutional cultures towards more strongly democratic (rather than bureaucratic) functioning, including those policy mechanisms, institutions, public spaces, forums, and venues available for deliberative justification and accountability. For example, many policy making and mediating institutions who were primarily engaged in more strongly deficit public education or citizen-consumerist models of civic science, who then seek to integrate more deliberative models, often do so through integrating dialogical and deliberative activities without first engaging with their institutional cultures. This maintains the practices and impacts of previous models and establishes institutional cultures which resist and most often render ineffective any new approaches being integrated. This may help to explain the ultimate failure of many participatory approaches.

To resolve this, Bickerstaff *et al.* (2010) caution that institutional rationalities are rooted in the “conceptualization of the expert-lay (science-society) relationship” (2010:490) and related institutional functioning, and therefore cannot be dealt with in simply procedural ways; instead they require interrogating the logics and ideals underpinning conceptions of expert-lay relationships. Many organisations are geared towards enacting and perpetuating such conceptions - the move towards more participatory and/or radical democratic models requires first that such conceptions be challenged and re-imagined. Towards this end, Bickerstaff *et al.* (2010) highlight that ‘institutional rationalities’ are often enacted in subtle ways which greatly impact democratic legitimacy, and are evidenced through the ways in which particular forms of knowledge are generated and used, how rules are used to manage systems of policy development and implementation or democratic participation, and how such rules are acted upon or ignored, resisted or adapted (*ibid*). Árnason raises several areas for consideration, including, a) the forms of literacy being promoted through institutional processes; b) the need to interrogate agendas promoted by institutions which lead citizens towards particular pre-determined outcomes, rather than promoting authentic forms of democratic deliberation; and c) the influence of often subtle cultural norms within institutions, and how they shape deliberative dialogues and mechanisms for public participation.

Árnason (2013) suggests that too much focus has been placed on the direct participation of citizens within scientific debate, and not enough has been placed on the trustworthiness and accountability of democratic institutions in facilitating and safe-guarding public participation within such debates. Árnason raises several areas for consideration, including, a) the forms of literacy being promoted through institutional processes; b) the need to interrogate agendas promoted by institutions which lead citizens towards particular pre-determined outcomes, rather than promoting authentic forms of democratic deliberation; and c) the influence of often subtle cultural norms within institutions, and how they shape deliberative dialogues and mechanisms for public participation. Rose and Novas (2004:448) advise that we should be guided by asking, “What kind of scientific literacy is being promoted here? What kinds of active biological citizens are being shaped, and to what ends?”.

A further aspect is the need to recognise that science, policy and publics (and their spokespersons) all operate on diverse systems of legitimation - that is - what they consider as credible, authoritative and legitimate, and their reasons for doing so, differ. Garvin (2001) argues

that each group within these different domains employs different and equally legitimate forms of rationality when generating knowledge, reviewing evidence related to risk or making decisions about what serves their interests and needs best. Within the policy making and implementation arena alone, there are substantive differences between what would be considered legitimate within citizen-consumerist models (which might legitimate public buy-in through social marketing strategies which account for and manage risk), compared to deliberative democratic models which would privilege the substance, quality and rationality of arguments, or radical democracy models which would require engagement with both consensus-making processes and authentic engagement with conflicting and challenging standpoints. Felt *et al.* (2009), Wynne (1992a) and Garvin (2001) argue that more democratically coherent systems of exchange and collaboration require that we examine and reconcile these diverse systems of legitimation in order to enhance democratic functioning and co-engaged knowledge flow between different groupings. The implication of the arguments above is that,

the way to restore public trust in science is to establish trustworthy institutions and practices. By removing the primary emphasis from participation to accountability, the focus is partly moved from the competencies and literacy of each individual to the “collective literacy” (Roth and Lee, 2002) ... of a community in which science is being taught, applied and criticised (Árnason, 2013:936).

Chambers (2003) argues that to do so, we need to evaluate and strengthen those institutions, venues, public spaces, forums and policy mechanisms available for deliberative justification and accountability.

Bickerstaff *et al.* (2010) stress the need to move away from simply evaluating deliberative or participatory processes, towards a focus on, “teasing out the relations between new ways of engaging citizens [publics] and the dynamics of institutional cultures, values and, in the longer term, trajectories of scientific and technological innovation and decision making” (2010:20). They also note that processes of democratic dialogue can themselves, influence institutional rationalities through strengthening internal systems of reflexivity (*ibid*). Institutions with shifting imperatives who then seek to integrate more deliberative models often integrate dialogical activities without first engaging with the institutional cultures that have been developed to support previous models of civic science. The new practices are then at odds with the established institutional cultures. In other words, such institutions adopt “a more pragmatic actioning of dialogue which work[s] with, rather than reconfiguring, existing structures of expertise, knowledge production, and decision making” (2010:17). They emphasise that,

it is only through more sustained work that examines the diverse organizational environments through which science is performed (from patent offices, regulatory offices to nongovernmental organizations) that we can understand the way in which different institutional rationalities emerge, persist, and enact scientific citizenship and indeed the production of knowledge. In attending to these institutional patterns of attitudes and behaviors, we can then more fully assess the conceptual and democratic significance of these deliberative experiments and, from this, future opportunities for fostering more creative and constructive forms of engagement that do genuinely move beyond the generalized talk and entrenched divisions of “Science” and “Society” (Bickerstaff *et al.*, 2010:21).

Here, the invitation is to develop institutional structures and systems which are capable of supporting, enabling and strengthening systems of commoning, while safeguarding and articulating common goods.

3.3.7. An Invitation to Expand Onto-Epistemic Imagination

What precisely is the territory I am tussling over here? Am I arguing about whether citizens should be seen as legitimate contributors to science or as legitimate contributors to knowledge production more broadly, in response to areas affecting their lives directly and indirectly? At the heart of this question is an interest in whether or not scientific knowledge is the only or even simply the best legitimate form of knowledge available to build knowledge about the world, not from an over-arching perspective, but rather in relation to situated, emergent social-ecological risks. These questions are important, because they delimit the focus and range of the debate, either within the legitimating structures of scientific knowledge production, or take us beyond it towards some other criteria for understanding what counts as legitimate knowledge and who might be considered a legitimate knowledge contributor. This returns to the arguments towards the common good and social-ecological justice raised in Chapter 1, and paths the way to the substantive arguments about epistemic cultures presented in Chapter 2.

The two central interests in this critique are: What is the role of ‘the public’ in knowledge production? Are the public reviewers, commentators, challengers, or contributors to scientific knowledge? And is scientific knowledge the only form of legitimate knowledge within such interactions? Terms such as “negotiated science” and “people’s science” serve to obscure the foundational nature of what is being debated; is it scientific knowledge and knowledgeability that is being debated, or the ethical implications of such knowledge for both the societies we live in, and the social-ecological systems we wish to foster into unknown futures.

If we recognise and use as our starting point, the reality that addressing contextual challenges requires more than scientific expertise, then we open up a space to reclaim a more just position for citizens. From here, we are able to acknowledge that citizens may be able to contribute other forms of knowledge that would render choices, decisions and interventions into local, national and global contexts more contextually-coherent, and aligned with a broader range of legitimacy criteria than those used to warrant scientific knowledge (for example, other forms of ethics, local social and political contexts, alternative temporalities for development, social justice imperatives, cultural and indigenous knowledges, etc.). The shifts in the field of civic science seem to indicate a wider and more radically democratic space for publics within science-policy-public relationships. There is a growing recognition that science is not the only (or even best) form of knowledge to use in avoiding or resolving risk, and that publics are holders of diverse forms of knowledge, in addition to bringing to the fore particular contextual experiences. The debate seems to have shifted from 'how to involve the public in understanding techno-science, and therefore supporting it?' towards '*how do we build knowledge, including science, in response to social-ecological risk and ongoing expansions, innovations and developments?*'.

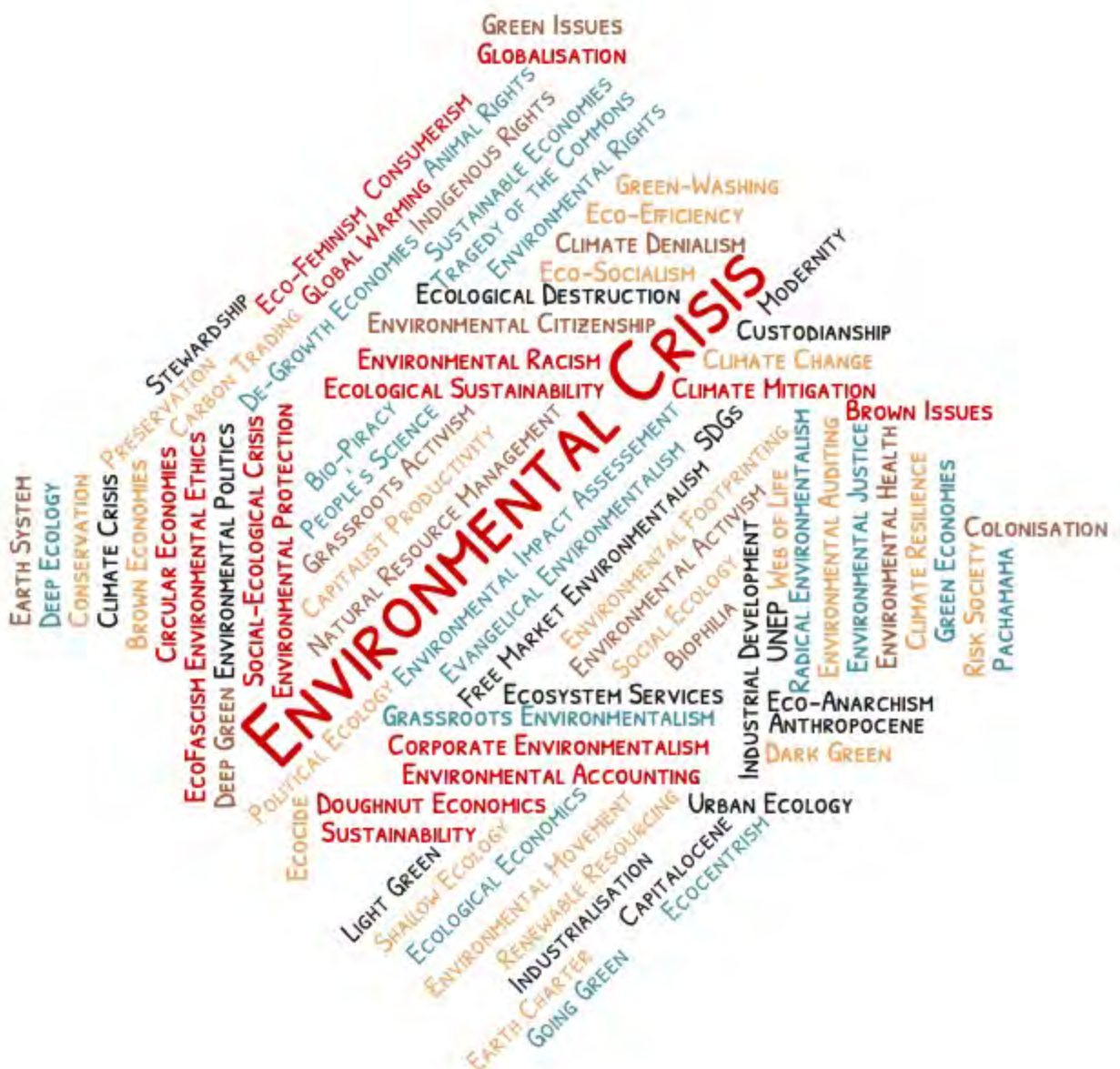
Rather than viewing public participation as contributing to or validating techno-science scientifically, resulting in a number of legitimacy and expertise-related issues, what would happen if publics were framed as contributing other forms of expertise which they could legitimately claim to contribute, and such expertise was engaged in dialogue with science and scientific experts? Such expertise may well be leveraged to make decisions about techno-scientific research, risks and innovations, but would not be positioned against expert scientists, but rather in dialogue with them, and across a broader terrain of knowledges, priorities and ways of being in and knowing the world - in other words, what would an onto-epistemologically robust politics of knowledge look like? How might it be strengthened, and which types of institutional development would we need to facilitate such a politics? The onto-epistemic invitation here, is to develop "institutional habits of thought that attempt to come to grips with the limits to human understanding and acknowledge from the start, the need for plural viewpoints and collective learning" (Bickkerstaff et al., 2010:19), and which are grounded within 'technologies of humility' (Jansanoff, 2007, 2003), towards institutions that do not automatically and hierarchically presume the epistemic authority, neutrality, or unanimous legitimacy of science over other ways of knowing the world.

The final critique in this chapter focuses on the construction and conceptualisation of Anthropocentric risk, and the mediational role that such a conceptualisation engenders in epistemic cultures convened in response of social-ecological risks. Where the first critique considered the mediational role of dualistic sorting, and the second, the role of mediating organisations and their epistemic cultures, the final critique looks at the mediational role of framings of social-ecological risks and their influence on risk-responsive epistemic cultures.



Figure 14: Visual summary of post-abyssal expansions in Critique 2

Critique 3:
The Construction of
Environmental Risk in the
Anthropocene: *A Critique of
Knowledge Production in
Response to Risk*



3.4. The Construction of Anthropocentric Risk: A Critique of Knowledge

Production in Response to Risk

Notions of 'the environmental crisis' and 'the Anthropocene' (or human-generated risk) have become mainstream amongst most scientific, state and practice fields dealing with matters of risk related to the Earth System and those environmental resources required to support human life. These systems of activity take as their starting point, a particular set of foundational ideas about such an environmental crisis. The broader knowledge culture they enact is saturated with particular ways of articulating and responding to such risk, and such conceptualisations of risk provide a powerful call-to-arms for volunteers, scientists and other collaborators seeking to contribute to risk mitigation and resilience strategies. These concepts underpin numerous intersecting areas of activity, including research funding, civil funding, and governance funding, formulation of scientific questions, and enactment of both research and response to perceived environmental risks. However, less attention is given to how the concept has been, and continues to be framed in quite historically particular ways.

My argument, in this section, is that these foundational starting points are troublesome for a variety of reasons, including that they inhibit commoning, and foreground dualistic notions of ontology. Instead, drawing on a range of expansive scholarship, I argue that a conceptualisation of historically-situated *relational* social-ecological risk provides a stronger and more just and generative basis for knowledge co-production in response to risk, demonstrated through the more advantageously post-abyssal notion of the Capitalocene. I focus on the concept of the Anthropocene as one which has come to dominate framings of contemporary environmental risk, and through which a teleological narration of environmental risk is often reconstructed. I then engage a post-abyssal expansion through which knowledge workers might begin to re-frame and re-conceptualise social-ecological risks towards the common good, as well as expand the onto-epistemic imaginaries we leverage through epistemic activity. This critique continues the arguments presented in earlier sections of the thesis, this time taking the conceptualisation of anthropocentric environmental risk as the starting point for knowledge production.

Ultimately, I aim to provide a critique of the hegemonic construction and propagation of 'environmental risk' as resolvable through objective techno-scientific knowledge and intervention, and to propose a more generative and expansive process of onto-epistemic

imaginaries leveraged in response to the common good. In critiquing dominant anthropocentric narratives, I drew on the original article by Crutzen and Stoermer (2000), as well as seven⁵⁵ additional articles. Articles were selected because of high citation rates (between 1000-5000), which I took as an indicator of scientific influence. I consider the utility of the current framing and its implications for generating knowledge and responses to social-ecological risks, and contributing to the common good.

3.4.1. Historical Framing of Environmental Risk

Well before the scientifically substantiated environmental movement began, many groups across the Earth had already been engaging in various and diverse forms of knowledge production about the risks generated through human interactions with the Earth Systems they relied on, and formed part of. For example, there are records of conservation practices being formally instituted in India as early as 256 BCE through the edicts of King Ashoka; the greek physician Hippocrates observed the relationship between climate and health; Greek physician Galen observed the danger of acid mists associated with copper mining; the Roman emperor Justinian described environmental commons including air, running water, the sea and seashores, among many other examples (Kovarik, n.d)^{56/57}. Dauvergne (2009:xli) summarises that,

[b]y the time of at least the 17th century, various scholars and state officials were already calling for greater efforts to preserve, conserve, and manage natural systems. By the 19th and early 20th centuries, as consumption of natural resources began to rise alongside industrial production and growing populations, more and more governments, including some colonisers, began to implement “scientific” management of resources (such as sustained yield management for timber) to try to ensure more efficient use of natural resources and lessen unnecessary degradation and unwanted consequences (such as soil erosion and flooding) ... Still, the word *environment* only began to take on its more modern political, social, ecological, and global meaning during the 1960s and early 1970s, as public demands for cleaner and safer living conditions became more vocal (Emphasis in original).

Numerous cultures practicing relational ontologies have an even longer history of integrated environmental management, and social-ecological management practices, and developed

55 (citations @ time of reference). It is interesting to note that the majority of these papers have been produced out of the same research community of Earth System scientists.

Lewis & Maslin (2015) - 1733 citations; Steffen *et al.* (2007) - 3095 citations; Steffen *et al.* (2011a) - 1877 citations; Steffen *et al.* (2018) - 1053 citations; Steffen *et al.* (2011b) - 1429 citations; Steffen *et al.* (2015) - 1669 citations; Haraway (2015) - 1341 citations - Note that Haraway offers a strong counter-narrative to the main body of work defining the Anthropocene.

56 An excellent resource to track the history of environmentalism, and the source of these moments in history is environmentalhistory.org. The resource includes both moments of environmental crisis, as well as environmental responses, across a range of cultural and ontological traditions.

57 Dauvergne (2009) offers another useful historical tracking of key moments within the conceptualisation and enactment of environmentalism - one which consciously seeks to offer a balanced narration of environmentalism without centralising global north contributions, while consciously attempting to understand the influences and contributions of the global south.

ontological and epistemic systems designed to track and respond to environmental changes, as well as complex social systems which integrated social-ecological management systems into everyday practices. These knowledge systems can still be evidenced through diverse indigenous cultures, for example.

The framing of negative human impacts on the environment has a fairly short history within the western sciences. Malthus's publication, *An Essay on the Principle of Population* in 1898 offered one of the earliest scientific predictions about the impact of rapidly increasing human populations on food security. The discovery of carbon dioxide accumulation in Earth's atmosphere by Revelle Keeling in 1957, Rachel Carson's 1962 publication *Silent Spring*, which linked pesticides to biological impact, and Rowland and Molina's discovery of ozone-depleting chemicals in the early 1970's were amongst the first formal scientific signals denoting a shift in the study of the natural world in the western sciences. They all raised to awareness the impact of humans on the Earth System (rather than investigating the ordering of the natural world). Ehrlich's *The Population Bomb* published in 1968 heralded the start of much scientific attention on impacts of population growth on natural resources (Dauvergne, 2009). Hardin's *The Tragedy of the Commons* was also published in 1968, similarly bringing attention to an increasingly urgent need to better manage and govern natural resources. Globalised notions of the environment finally came into prominence with the image of 'the blue marble' - the first colour picture of the earth, captured in 1972. Such images provided graphic illustrations of an interconnected Earth System which encompassed industrially designated 1st, 2nd and 3rd worlds into one world. These findings stimulated a range of environmental justice and research movements aimed at both establishing better understanding of the causes and effects of human impacts on the environment, and stimulating social actions in response to these understandings.

Keeling's contribution was focused on precise scientific measurements of carbon dioxide, and formed the basis for a scientific framing of first global warming and most recently, climate change (1957). Rowland and Molina's work of the early 1970's similarly fell within the rigours of western scientific measurement, and together with Paul Crutzen's work, further refined and developed the currently dominant climate and human-induced climate measurement systems which form one of the core foundations of climate change-related scientific work and the conceptualisation of the Anthropocene today. While the rigorous development of measurement and observation protocols undeniably enabled risky environmental interactions to be

evidenced, they have also led to quite specific framings of environmental risk - framings which are embedded within the specific context of colonial, hegemonic rationalities. For example, such protocols distinguish and differentiate nature from society, and tend to 'clean out' heterogenous human-environment interactions, or the histories of such interactions. The patterns of resource colonisation, and the gross social-ecological violations which enabled large-scale resource appropriation remain invisible. Impacts are reduced to clearly delineated and precisely (often chemically or geologically) defined impacts, devoid of their social-ecological complexities, injustices or rationalities, and interactions arising from such definitions of risk tend to generate similarly focused and specific interventions which are aimed at reducing carbon emissions (for example), rather than engaging with the broader relational interactions which gave rise to the systems related to increasing Earth System instability.

In contrast, Carson's work began more controversially, with the presentation of a relational account of human-induced environmental degradation - one which drew on an ecology of knowledges (1962). Her work brought to the fore the need to reconsider how we imagined and represented our relationships with the natural world, in addition to articulating multiple forms of knowing within these relationships. For example, *Silent Spring* includes articulations of intuitive, emotional, embodied, indigenous, situated and metaphysical knowledges in the forms of embodied experience, oral histories, dreams, situated experiences, etc. Carson worked to challenge the precarious conceptualisations of democratic freedoms, and the ways in which they were constructed and enacted, and argued for re-framing entire relational systems, rather than changing clearly-defined and specifically focused human-environment interactions. Unfortunately, the wider base of knowledges informing Carson's articulation of *Silent Spring* remained largely obscured, while Carson was politically and scientifically ostracised for this form of knowledge production. Today, it is her scientific work and arguments which are foregrounded, both within environmental sciences, as well as within environmental justice movements more widely.

With the call to arms sounded by Carson and others, researchers like Rittel and Webber (1973) began to confront the challenge of using science to address complex and cumulative problems - what they described as wicked problems - thereby adding to the awareness of impact, their insights into complexity. The need to limit industrialisation rose to prominence in the 1970s,

through works such as Meadow *et al.*⁵⁸'s *The Limits to Growth* (1972) which modelled economic growth impacts on natural resources, and Schumacher's *Small is Beautiful*, in 1973. In more recent times, Beck (1998, 1995, 1992) and Giddens (1999) articulations' of risk society, and its features of uncertainty and individualisation, provided a framing to describe the systems of risk management in response to modern social and environmental risks, and the privileging of some groups over others in these arrangements. Underpinning both of their framings of risk society, is the conceptualisation of modernisation underpinned by techno-scientific industrialisation. Both authors raised to awareness the relevance of human-induced risk - that is, humans, through their modern lifestyles, began to produce risk both for themselves and for the natural environment, rather than simply being at risk from natural disasters and other forms of naturally occurring risk. As Frandy and Cederström (2017), point out, however, there is a privileging of colonial cultures within such conceptions of environment, environmental risk and risk responsiveness.

3.4.2. Rise to Prominence of the Concept of the Anthropocene

In 2000, atmospheric chemist Paul Crutzen and marine science specialist Eugene Stoermer⁵⁹ framed a scientific concept that substantially shifted global perspectives about human-induced impact on the Earth System - that of the 'Anthropocene'.

Considering these and many other major and still growing impacts of human activities on Earth and atmosphere, and at all, including global scales, it seems to us more than appropriate to emphasize the central role of mankind in geology and ecology by proposing to use the term "anthropocene" for the current geological epoch (Crutzen & Stoermer, 2000:17).

In response to a range of human-induced disturbances within the Earth System and its regulating cycles, the concept was proposed to "capture this quantitative shift in the relationship between humans and the global environment", and to signify "that humankind has become a global geological force in its own right" (Steffen *et al.*⁶⁰, 2011a:843; Steffen, Crutzen & McNeill, 2007). It was initially leveraged as a geographical term - one based on human-induced climatic variance related to atmospheric carbon content at a scale significant enough to alter the functioning of the Earth System. Later, as the concept began to be taken up within various other disciplines, the concept blurred to include a more expansive system of human-environmental relationships and impacts - most often in terms of negative human impacts on the environment.

58 Meadows, D. H., Meadows, D. H., Randers, J., & Behrens III, W. W.

59 Although Stoermer originally coined the term 'Anthropocene' in the 1980's, the term gained prominence in a co-authored article in 2000.

60 Steffen, W., Grinevald, J., Crutzen, P., & McNeill, J.

Within geological disciplines, the term has become similarly expansive. For example, Steffen *et al.* note that:

[i]n addition to the carbon cycle, humans are (i) significantly altering several other biogeochemical, or element cycles, such as nitrogen, phosphorus and sulphur, that are fundamental to life on the Earth; (ii) strongly modifying the terrestrial water cycle by intercepting river flow from uplands to the sea and, through land-cover change, altering the water vapour flow from the land to the atmosphere; and (iii) likely driving the sixth major extinction in Earth history (Steffen *et al.* 2011a:843).

The concept 'Anthropocene' brings focused attention to the wide-scale impact of humans on the Earth System, specifically through the impact of industrial activities, and the accompanying perception of modernisation.

To assign a more specific date to the onset of the "anthropocene" seems somewhat arbitrary, but we propose the latter part of the 18th century ... we choose this date because, during the past two centuries, the global effects of human activities have become clearly noticeable (Crutzen & Stoermer, 2000:17).

Although this periodisation is among those aspects of definition that remains highly contested, and reference to the Industrial Revolution as the start point of the Anthropocene has all but been rejected in current times, the term still holds this reference in many contexts outside of the geological sciences. Within the geological sciences, the start date of the Anthropocene coinciding with the Industrial Revolution was largely rejected because geochemical levels of greenhouse gasses are not clearly evident at this point. None-the-less, the focus remains on articulating human impact on the Earth System. as illustrated below:

Human activity profoundly affects the environment, from Earth's major biogeochemical cycles to the evolution of life ... Human actions have released 555 pentagrams of carbon (where 1Pg=10¹⁵g = 1 billion metric tons) to the atmosphere since 1750 ... Human action also affects non-human life. Global net primary productivity appears to be relatively constant; however, the appropriation of 25-38% of net primary productivity for human use reduces the amount available for millions of other species on Earth ... Furthermore, human actions may well constitute Earth's most important evolutionary pressure. ... Human activity has clearly altered the land surface, oceans and atmosphere, and re-ordered life on Earth (Lewis & Maslin, 2015:172).

The conceptualisation of the Anthropocene highlights that,

(i) natural processes can no longer be defined as independent from human influence, and (ii) natural forms and processes have been influenced by humans to a very high degree. Sometimes, human intervention is manifest; sometimes, it is not. Some other times, as with the climate, is not even planned [sic] (Arias-Maldonado, 2014:8).

The term has worked to generate a diverse range of activities across both the natural and social sciences, and includes widespread debate about how we go about addressing the negative impacts of humans on a planet-at-risk, and more recently, the impact of some groups of humans on others.

Recognising that the term was coined within geology, we must also bear in mind that many debates about the term, its advent, and relevance, are still rooted in geological terms. Simultaneously, the term has also migrated across disciplines, and been mobilised in other ways. So how might we work with such an idea coherently, across both definition and application? The definition, if geological, is specifically so - it relates to perceivable geological changes referenced within the discipline of geology. To use the geological definition to conceptualise and formulate responses to the Anthropocene is limited, because from this perspective, the start of a geological age (as relates to perceivable geological change) is not the appropriate starting point for accounting for such changes, nor for formulating responses to such changes. If the Industrial Revolution is the geological marker (for example), then the cause of the Industrial Revolution, the social-ecological relations constituting and leading to the Industrial Revolution, are the appropriate starting point for understanding how, why, and what should be done about various and diverse impacts. If humankind is the defining feature of anthropocentric change, then all aspects of human life must be encompassed in defining and understanding, as well as responding to anthropocentric impacts, foremost among them, our relationships with each other, the web-of-life, and the Earth System.

Currently, as Lewis and Maslin (2015) point out, “the formal definition of the Anthropocene makes scientists arbiters, to an extent, of the human-environment relationship, itself an act with consequences beyond geology” (2015:171). They note that,

Definitions will probably have effects beyond geology. For example, defining an early start date may, in political terms, ‘normalize’ global environmental change. Meanwhile, agreeing a later start date related to the Industrial Revolution may, for example, be used to assign historical responsibility for carbon dioxide emissions to particular countries or regions during the industrial era (Lewis & Maslin, 2015:171).

In response to, and support of, the framing of the Anthropocene, Rockstrom *et al*⁶¹. (2009:472) developed a framework on planetary boundaries - a system of nine key indicators or tipping points aimed at outlining a ‘safe operating space for humanity with respect to the Earth System’, all related to the planet’s bio-physical subsystems and processes.

61 Rockström, J., Steffen, W., Noone, K., Persson, Å., Chapin, F. S., Lambin, E. F., Lenton, T.M., Scheffer, M., Folke, C., Schellnhuber, H.J., Nykvist, B., de Wit, C.A., Hughes, T., van der Leeuw, S., Rodhe, H., Sorlin, S., Snyder, P.K., Costanza, R., Svedin, U., Falkenmark, M., Karlberg, L., Corell, R.W., Fabry, V.J., Hansen, J., Walker, B., Liverman, D., richardson, K., Crutzen, P., & Foley, J.A.

3.4.3. Troubling the Conceptualisation of the Anthropocene

The conceptualisation of the 'Anthropocene' has provided significant service by foregrounding and providing an integrated systemic framework for evidencing some impacts of particular types of human-environment interactions which are risky and risk-generating. At the same time, the dominant narratives underpinning the concept remain contentious. Haraway (2016) raises the concern that how we think about things have wide reaching implications for what becomes visible, and what remains hidden, and that the concept of Anthropocene obscures much of significance. She resonates with Crist (2016), who argues that the ways in which we choose to live are extensions - manifestations - of the concepts we use; they foster and legitimate a specific range of ideas and afford a range of possible actions, while limiting or negating others. The anthropocentric framing of environmental risk sets up particular causal relationships, foregrounding a select range of variables contributing to environmental risk, while maintaining the society-nature divide enacted through dualistic sorting.

Narratives arising in relation to anthropocentric risk tend to be dominated by a list of human-induced risk and riskiness, the evidencing of such risky behaviours, and suggestions for how these risks can be mitigated, managed and resolved. Such lists tend to segment systemic risk into specific foci, like carbon emissions, phosphorus depletion, reduction of global fishing stocks, etc. However, as Haraway stresses,

it's more than climate change; it's also extraordinary burdens of toxic chemistry, mining, depletion of lakes and rivers under and above ground, ecosystem simplification, vast genocides of people and other critters, etc, etc, *in systemically linked patterns* that threaten major system collapse after major system collapse after major system collapse (Haraway, 2015:159, my emphasis).

It is the systemic relations between a fully intra-active and integrated web-of-life that impact the system, the connections, relations, disruptions, disconnections and patterns that generate particular systemic states, rather than any one moment-in-time measurement or state of an individual aspect of the interconnected system. Reflecting on what he terms 'socionatural relations', Arias-Maldonado (2014:8) asks, "does the Anthropocene entail a substantial change of our understanding of such relations and nature itself?". He points out that "we need to understand what the Anthropocene says about 'socionatural relations' before we can articulate a moral answer to it" (*ibid*:8). In other words, it is not so much that humans are now having a noticeable impact on the Earth System at a whole-system scale; rather, more precisely, it is that a particular set of human / Earth System relationships have and are giving rise to observable changes within the Earth System. We must recognise that humans have related to and impacted

the Earth System at diverse scales for all of our existence. Neither is there only one clear way of relating to the Earth System among contemporary (nor historical) societies, or even sub-groupings within societies. The broad, all encompassing framing of anthropocentric risk is precarious - more so than any specific arguments leveraged to foreground the term. If we were able to more precisely identify the types of risky relationships between human-and-Earth System, we might more precisely and justly be able to begin (re)imagining those relationships.

Moore (2017), Haraway (2016), Crist (2016), Hartley (2016) and others have allied in arguing for the limitations of framing the contemporary social-ecological crisis in the geophysical terms of the Anthropocene. They raise, between them, a range of limitations with far-reaching implications for using the Anthropocene as our defining frame of reference for the nature and origins of the social-ecological crisis. These include (among others),:

1. Its basis on a dualistic ontology of the world (and the accompanying individualisation of the self);
2. Its representation of humans as a homogenous group, with equal standing and equal impact on the Earth System;
3. Its positioning of ('modern') humans as the dominant species on the Earth, framed outside of, and above the web-of-life;
4. Its consequentialist framing of the social-ecological crisis (with an ecological bias);
5. Its representation of industrial development as a progressive march forward; and
6. Its linear narration of consequences, which are technologically rooted, and often, framed as techno-scientifically resolvable.

Each of these were touched on in previous chapters and sections, especially in relation to epistemic and social injustices. They are relevant to this study because understanding how they are operationalised in epistemic systems generates opportunities for more strongly just post-abysal expansions of them, and are explored in more detail below.

3.4.3.1. *The formulation of the autonomous individual self as the basis of the anthropos*

One of the central features of any activity related to social-ecological justice is the relationship between the self - the individual human or anthropos - and the rest of the world. In current times, within Occidental societies and their (ex)colonies, the individual self is privileged and protected - often to the detriment of wider society, the web-of-life, or the Earth System as a whole. With this notion of 'self' comes a cultural understanding of humankind's position within

the web-of-life, including the privileges and responsibilities that position bestows. In Chapter 1, I made the argument for re-orienting collaborative knowledge production towards the common good, underpinned by a relational conception of the web-of-life. From this perspective, knowledge co-production as 'commoning' would require a re-organisation of privilege and obligation between individuals, communities and the web-of-life. To do so requires some understanding of the ontological roots of contemporary conceptions of the autonomous individual as the most normative and privileged conception of the self. Psychologist Philip Cushman (1990:600) argues that, "[b]y studying the configuration of the current self, we will come to have an enlarged perspective on the forces that shape it, the discourse that justifies it, the consequences that flow from it". He lays down a challenge to more deeply examine what has become seen to be an unchangeable trans-historical conception of the self as autonomous, bounded and masterful - one where such an autonomous self is hierarchically positioned above 'everything else out there' through dualist sorting (Taylor, 2007 in Jones, 2010).

Jones (2010:49) provides a substantive argument that,

there is a particular view of the self that is so pervasive that we accept this idea in unquestioning and uncritical ways. The idea of the self as bounded, unitary, autonomous, and masterful - or more simply, the bounded, masterful self - deeply affects our personal perceptions as well as the thinking of social theorists ... [most theories, he notes] ... fail to appreciate the nature and impact of these assumptions with the result that most theoretical perspectives still take the bounded, masterful self as a given.

Packaged into this view is the assumption that,

the essence of a human being resides within an individual human mind, and the moral consequence of that assumption is that the needs of the individual should be given priority relative to the needs of any relationships or communities to which the individual might happened [sic] to belong. This means that whenever there is a conflict between the needs of the individual and the needs of a relationship ... [the needs and rights of the individual] ... should always be taken care of even if it is at the expense of the relationship (Jones, 2010:55).

Understanding the ontological foundations of the autonomous self is especially significant within a global context, where such a notion of individual self is common within the metropole which stands at the centre of industrialised, anthropocentric society. Both Cushman (1990) and Jones (2010) point to Cartesianism as a significant moment in the conceptualisation of the self as bounded, autonomous, unitary and masterful. Resonating with Cushman, and, through his explication of Charles Taylor's 'moral ontology'⁶², Kerr argues that such an adamant centring of individual rights encourages us to overlook obligations which sustain the communities within

⁶² Although Taylor and Jones both use the term 'moral' in their work, I have chosen the term 'ethical' to maintain the axiological charging of the ideas, while creating some distance from socially stagnant ideas of right and wrong, good and bad. I also re-present Taylor and Jones' ideas in these terms for the sake of coherence.

which individuals are themselves sustained (Kerr, 2004), and that commitments and related values that are not of immediate benefit to the individual are pushed aside (Jones, 2010).

In his critical summary of Taylor's work, Kerr (2004) shares insights as regards 'the self' and 'the good' (including the common good and the good life). Taylor argues that there can be no conception of the self as autonomous nor self-sufficient outside of society, and in fact identity as it pertains to the self can only be achieved and maintained through willing inter-relationships mediated by the common good within shared cultures (*ibid*). For Taylor an autonomous, individual notion of the self is ethically untenable because it divests us of those ethical resources that would enable us to live the good life. This anthropocentric view precludes the possibility for goods that fall outside of human creation, and designates to society (and I would add, the entire Earth System) a primarily instrumental purpose for fulfilling individual rights.

Instead, Taylor argues for the need to co-sustain societies and cultures through which goods are made available, and which allow for the possibility of those goods which arise and contribute to goods beyond the individual and even further, beyond the human—I believe he proposes a good life as an aspect of the common good. Central to Taylor's argument is a critique of any ethics which are based on the rationalist reasoning of the natural sciences which, according to Taylor, are destructive because they require us to step outside of our ordinary experiences of the world. Instead he argues for a more immersive, situated and contextual grounding of our experiences in the world, where we engage with such experiences more directly and thus co-create those good lives that are interwoven with, and contribute to, the common good. While Taylor (in Kerr), and Cushman, both argue for a partial return to a more relational conception of self, neither dismisses the historical contexts of social subjugation and conformity which led to the formation of the autonomous self as a new form of freedom from social oppression. Instead, they argue for the need to reconsider, and more rigorously question, the assumptions underpinning the contemporary version of the autonomous self, and how this self might be reconnected into the socio-cultural milieu.

3.4.3.2. A premise of dualistic rationality

Critique 1 explicates a range of challenges with rationalities emerging from dualistic reasoning, and argues for their incoherence. I will not repeat those arguments here, other than to note that

Anthropocentric conceptualisation is premised on dualistic rationality. Moore (2017, 2016) highlights four key thought-procedures shaping the modern world that arise from the Cartesian dualistic roots on which the Anthropocene is premised:

- The imposition of ontological status of things onto entities as opposed to relationships (also see Latour, 2004 and Santos, 2004);
- The centrality of dualistic forms of reasoning (either/or as opposed to rather than, both/and, society/nature splits, etc.);
- The use of applied science to gain purposive control over nature; and
- The designation of nature as an object (Latour, 2004), and appropriation of women and colonies into nature (Moore 2017, Santos, 2004).

In this regard, dualistic sorting is visible in the epistemological tendency to re-assign substantive ontological status to things, rather than maintaining them within their realised relations. This reassignment disconnects things from their relational networks and makes them available for discrete and artificially disconnected manipulation in the service of humans, and especially, of capital (or other socio-political goals). In effect, it creates a blindspot around relations and connections, which fall out of view in the legitimated procedures of scientific knowledge-building (Latour, 2004; also see 2.7). Essentially, the dualistic rationality underpinning the conceptualisation of the Anthropocene forwards a particular, unjust and incoherent account of human-nature relationships - one which simultaneously critiques and calls to account such relations, while also reinforcing such dualisms, and the neoliberal hegemonies and systems of Capitalism premised on, and arising from them (Moore, 2017).

Bijker, Hughes and Pinch (1990), for example, describe the ways in which dualistic views of reality affect the adoption and development of technology in ways which contribute to environmental degradation. They conceptualise technology as a form of 'embodied science', and describe how dualism enables 'closure' once scientific assessment and processes of legitimation have been winnowed from various applications of technology - technological problems become 'solved', and technologies stabilised. At this point, 'closure' is established, and technological development no longer responds to environmental changes induced by that technology's application to the world (Also see Latour, 2004). Similarly, Freudenburg, Frickel and Gramling (1995) note that western societies are pervasively defined through society/nature dualism, which they argue, contributes to environmental degradation through a distortion of social-ecological relations. They point out that we are "prisoners of our own perspectives" by

the very "taken-for-grantedness of our socially agreed-upon definitions" (Freudenburg et al., 1995:388). Another example of the slippage which occurs through dualistic accounts of social-ecological relations, is the tendency to describe humans (and also other beings, and the Earth System) in terms of chemical output and impact (Lövbrand, Stripple & Wiman, 2009), or in terms of subjective interactions, rather than as integrated ways of being and becoming in the world, thereby maintaining dualistic division across all scales and systems.

3.4.3.3. The anthropocentric homogenous, ahistorical grouping of humans

Carbon-derived anthropocentric starting points focus us on evidenced geochemical outcomes, which we then track backwards towards causes, while simultaneously obscuring generative causal relations. This is demonstrated in Steffen et al. (2007), for example. Here, this start enables a focus on resource mobilisation, rather than the social relations on which such mobilisation was premised. What remains in view is that Eurocentric civilisation required additional resources and that resource appropriation from other resource bases pushed them to the fore as a civilisation, and that this renewed resource relationship led to the transformation of the world into a more industrialised avatar of itself. The focus is on the use of fossil fuels (resource), and most often, the response to this narration of risk is the management of fossil fuels and fossil fuel-dependent industries. Human impact is only described in relation to the 'natural' aspects of the Earth System, neglecting human-on-human impacts.

While the Anthropos - human - is understandably positioned as central within the Anthropocene, articulation of the features of the Anthropos remain largely absent. In general, descriptions of the Anthropocene (especially earlier conceptualisations, which remain dominant within many scientific circles), construe humans as one homogenous group (Moore, 2017; Hartley, 2016), who seemingly act equally in the human cultures impacting on the planet, summarised by the phrase 'the human enterprise' (see for example, Steffen et al. 2011a). Such human impact is articulated in two ways - enlightened modernity (which is foregrounded as the pathway for resolving such riskiness), and uncaring overconsumption (the cause of such riskiness). However, such a representation is inaccurate - even within Eurocentric societies - as well as within many cultural groupings forcibly shifted off lands, who continue to call for reconstituting more balanced relationships with the Earth. Notions of Pachamama, Bhumi-mata, Gaia, Terra, Haniyasu-hime, Spider Woman, Oya, Gorgo, Raven, A'akuluujjusi, and many more point to substantively different ways of relating to Earth and Earth System.

Foregrounded in the notion of the Anthropocene are conceptions of 'civilised man', 'modern civilisation', 'fully modern humans', 'the human enterprise', 'developed' and 'developing' countries and worlds, 'humanity's relationship with the Earth System' (with emphasis on the singular in relationship), ecological impacts (rather than social-ecological impacts), and 'contemporary civilisation' (rather than civilisations)⁶³. Their descriptions centralise Eurocentric notions of what it is to be human and civilised, and exclude the complexity of environmental movements, interests, and ways of being on, with, and for the environment (Haraway, 2015). These phrases signal key characteristics of the Anthropos, which is raised to such a central role within the Anthropocene, and dismiss the contemporaneity of those groupings of people who fall outside of, or enact a hybridity of social relations beyond or outside of, industrialised, capitalised relations (Santos, 2007, also see 2.9). Again, this is evidenced in accounts, which for example, reference agrarian and hunter-gather societies in the past tense, rather than in contemporary terms, as reflects the reality of the world (see for example, Steffen *et al.*, 2007).

Eurocentricity is demonstrated in claims such as:

Humanity has responded to the decline in biodiversity with an increase in a range of conservation actions (Steffen *et al.*, 2011a:856).

We are the first generation with the knowledge of how our activities influence the Earth System, and thus the first generation with the power and the responsibility to change our relationship with the planet (Steffen *et al.*⁶⁴, 2011b:2).

Additionally, claims that environmentalism began in the 1960's with the exception of 'some reflective people', likewise demonstrate this tendency (Steffen *et al.*, 2007). What this perspective excludes are all of the systems of human-environment relationships enacted along more sustainable relations, many before the recognised beginning of the environmental crisis in the 1970s. Many cultures related, and continue to relate to, the web-of-life in ways that reflect markedly different ontologies to those centralising scientific or even Abrahamic theological ontologies. These cultures, themselves, have undergone sustained persecution and epistemicide (Santos, 2016) alongside the rapid decline of the biological systems which were colonised away from them. What the term "Anthropocene" clearly excludes, are conceptualisations of human-environment relationships which do not foreground industrialised and capitalist models of 'civilisation'. The exception to an overall homogenised notion of

⁶³ These particular phrases were sourced in Steffen *et al.* (2011a), with articulations in diverse other literatures narrating the Anthropocene.

⁶⁴ Steffen, W., Persson, Å., Deutsch, L., Zalasiewicz, J., Williams, M., Richardson, K., Crumley, C., Crutzen, P., Folke, C., Gordon, L. and Molina, M.

Anthropos, is the distinction between unequal environmental impacts between the global north and industrialised societies (which more recently, includes the impacts of Chinese and Indian economic activities), and developing societies more widely, and the failure of industrially developed societies to adequately respond to the crisis in meaningful ways (*ibid*). Of course, such a distinction is, itself, hegemonic in nature because these societies are themselves heterogeneous in nature. Steffen *et al.*⁶⁵ do acknowledge that,

The original Great Acceleration graphs [through which many anthropocentric risks are evidenced] (Steffen *et al.*, 2004) treated humanity as an aggregated whole and did not attempt to deconstruct the socio-economic graphs into countries or groups of countries. This approach — and the common treatment of humanity as a whole in discourses about the Anthropocene — has prompted some sharp criticism from social scientists and humanities scholars that such treatment masks important equity issues (Steffen *et al.*, 2015:11).

... by treating ‘humans’ as a single, monolithic whole, it ignores the fact that the Great Acceleration has, until very recently, been almost entirely driven by a small fraction of the human population, those in developed countries (Steffen *et al.*, 2015:11).

Even with these amendments and allowances, it remains clear that the term ‘Anthropocene’ is about a hegemonic anthropos (indicating a singular type) - civilised and modern, or on the way to becoming civilised and modern - rather than a more expansive and inclusive notion of anthropoi (the plural form of the Greek term). Moore (2017) argues that the distinction of humans as a single species within the web-of-life is constituted through a process of abstraction, rather than one of synthesis - it is a biological, rather than social, distinction. Many of the technocentric impacts identified within the body of research informing the conceptualisation of the Anthropocene can be traced to an industrially developed, Eurocentric vision of capitalist man (and those of us living ‘metropolitan’ lifestyles based on this way of being). By extension, it appears that to be considered part of the anthropos is to live in the image of the industrially developed western man (see for example, Steffen *et al.* (2011a:843), where “humankind, notably ‘civilized Man’” are credited as the causal factor within the Anthropocene, even while the knowledge of such ‘civilized men’ are foregrounded as the source of solutions.

While this framing of the anthropos is useful in capturing the accumulated impact of the human species on the Earth System, it fails to articulate or identify those human groupings, cultures and ways of being which have also been negatively impacted by these same activities (Moore, 2017; Hartley, 2016; McBrien, 2016). This blurring of who constitutes the anthropos into one homogenous group focuses epistemic productivity, and the forms of action arising from it,

65 Steffen, W., Broadgate, W., Deutsch, L., Gaffney, O., & Ludwig, C.

towards a particular set of human-nature relationships, while excluding epistemic activity and related actions which seek to redress human-human interactions implicated in the social-ecological crisis. For Latour (2004), Santos (2004), Haraway (2015), and others, it is the alliances and exchanges between and among nature and humans, taken together, which define the anthropoi. This is how we arrive at the 'who' that Crist (2016) challenges us to consider.

Although Crutzen and Stoermer associate the idea of the Anthropocene with the impact of 'humanity's' activities, the idea that 'humanity' as a whole is responsible for the changes in the Earth system associated with the Anthropocene is problematic. The Orbis⁶⁶ hypothesis directs us to the relation between the Anthropocene, colonialism and mercantile capitalism, while the 'Great Acceleration' hypothesis points to the connections between the Anthropocene, post-war consumer capitalism, and the geopolitics of the Cold War (Barry & Maslin, 2016:7).

The point is that while all humans, have an impact on the Earth System, such impacts are far from homogenised. It is as important to recognise which human-Earth System relations are contentious, and which cultural configurations have given rise to such relations, as it is to resist the romanisation of non- or pre-industrial societies. Reclaiming what Santos (2004) describes as 'wasted social experience' only becomes possible by recognising knowledges and ways of being that might expand the hegemony of western scientific thought in relation to risk. The citizen science projects engaged with in this thesis arose in a context of post-colonial and uneven industrial development, and address social-ecological risks which cannot be removed from this context. This argument is relevant to this study because it illuminates hegemonic constructions of risk, and highlights the need to re-think and re-conceptualise the heterogeneous nature of risk in context, and especially in post-colonial contexts.

3.4.3.4. Humans as the dominant species and outside of the web-of-life

Lewis and Maslin (2015:173), in their geological review of the possibilities of an Anthropocentric era and reflection on the authors of the earliest evidence-based written proposals, indicate that,

The wider records of these often deeply religious men show that a separate human epoch was likely to have been more strongly influenced by theological concerns—in particular, separating *Homo sapiens* from other animals and retaining humans at the apex of life on Earth—than by the appraisal of stratigraphic evidence.

Seminal texts such as Rockstrom et al's (2009) paper on planetary boundaries, and Steffen et al's (2011a) historical and conceptual framing of the Anthropocene, which foreground the impact of the social-ecological crisis to their impact on humans, and the maintenance of human systems,

⁶⁶ In reference to the start of colonisation and mercantile Capitalism.

share resonance with this centralised role of man-above-nature, even as they provide a robust case for the interconnected social-ecological relations between humans and the Earth System.

Crist (2016) points out that a key failing of the label 'Anthropocene' is that it greatly reduces the discursive space for challenging and confronting the positioning of humans (*anthropos*) as the dominant species around which all of nature is organised, and in this, it is conceptually deficient. More, it acts as a rationalising force resigning us to its actuality and inevitability (*ibid*). She notes that human history has unfolded by silencing nonhuman others whose qualities and abilities have been defined in western science as without speech, unique perspectives, or a vested interest in their own futures (*ibid*), and juxtaposing them with framings of humans as superior because of their abilities for speech, communication and the ability to learn across generations - especially written accounts which dominate the culture of the moderns (see for example, Steffen *et al.*, 2007).

Greatest among these limits for Crist, is the inability of the the concept of the Anthropocene to offer an alternative to the current conceptualisation of civilisation as a human-centric project. It acts to perpetuate the view that humans are at the centre of life on Earth, and closes off the possibility for reimagining ourselves as part of the web-of-life. For both Haraway (2016) and Crist (2016), the concept of the Anthropocene is constituted of strong organising discourses that forward a particular perception of the world which is troublesome - especially because of what it limits: that of the wider relationships and interdependencies, and the urgent opportunity for self-reflexive consideration of ourselves as one species within the web-of-life, in relationship with all the other species, places, and times, that constitute the web. Powerfully, they note that what is obscured by framing the Anthropocene as the root of the current social-ecological crisis, is that the ways of living that constitute relationships within the web-of-life are a choice - one that can be reflexively amended, rescinded or reconstituted, if we so choose.

Moore in turn, points out that the relations that have caused the modern world are not relations between humans alone, but encompass quite centrally, our relations within the web-of-life, encompassing other species, geologies and Earth System processes, in addition to the relationships within our own species (2016). Therefore, any conceptual framework that is used to frame our current social-ecological context needs to take account of both the plural relationships within our own species, as well as the plurality of relations with the rest of the web-

of-life. To acknowledge the extra-human complexity of these relationships is to take account of the projects and processes that act to reconfigure the relations of humanity-in-nature (Moore, 2016), and calls forth a more-than-techno-scientific approach to meeting contemporary social-ecological challenges. Moore's argument highlights the iterative evolution of humans and human environments, underscoring that while humans are distinct from their environments, they are also co-constituted and, in turn, act to co-constitute those environments. Therefore, rethinking humans in relationship with and as part of the web-of-life provides an important conceptual move in rethinking history, and in seeing humans as part of environment-making (Moore, 2017). This once again points towards the need for an articulation of a relational science which develops epistemic infrastructures which foreground relations.

3.4.3.5. A consequentialist framing of the social-ecological crisis

One of the key developments in moving from problem definition to solution formulation is the concept of the Anthropocene (Crutzen, 2002), which cuts through a mass of complexity and detail to place the evolution of the human enterprise in the context of a much longer Earth history. This analysis sharpens the focus on an overarching long-term goal for humanity—keeping the Earth's environment in a state conducive for further human development (Steffen *et al.*, 2011b:3).

Moore challenges us to ask, “[w]hat drives today’s disastrous state of affairs?”, and in asking this, to shift our attention from what he describes as the “consequences of environment-making to its conditions and causes” (2016:78). He highlights the absence of connections between processes for making this anthropocentric world (and power, wealth, inequality and work), and carefully frames what is made present when we begin to consider the current social-ecological crisis in these terms instead. He argues that underpinning the consequentialist argument of the Anthropocene are a series of abstractions connected into a cascade of consequences, substituted in place of the constitutive relations that make up the web-of-life in reality (Moore, 2017). In this scenario, nature is constructed as pristine before the advent of industrial development, safe in a harmonious relationship with the anthropos. Here we are able to begin the story of pristine nature in relationship with a homogenous anthropos - cleaned out of their complexities, codependencies, and both magnificent and ugly histories - a clean slate primed for the insertion of one single variable - that of industrial development (or more precisely, accessibility and use of fossil fuels). While this is not completely accurate, as evidenced by Crutzen and Stoermer⁶⁷ (2000) and Steffen *et al.*'s inclusion of some historical detail in their

⁶⁷ Crutzen and Stoermer (2000) and Steffen *et al.* (2011a) are seminal accounts of the conceptualisation of the Anthropocene.

account of the Anthropocene, it does seem to constitute the dominant narrative within Anthropocene literature shaped by geological narratives and Earth System sciences (2011a).

A consequentialist view has limited effectiveness in explaining how we have arrived at our contemporary context relationally, thereby foregrounding technocentric events, rather than relationship histories and geostories⁶⁸ (Haraway, 2016). Within such accounts, ecological risks are constructed as consequences of industrialisation, and social risks as consequences of ecological disruption, rather than both being historically rooted in a longer history of new forms of environment-making and social-ecology. Consequentialist framings limit both epistemic generativity and opportunities for responsiveness, holding us to a narrow set of pathways through which we might imagine and enact possible futures.

3.4.3.6. Industrial development and capitalist markets as a progressive forward march

Crist (2016) notes that history is often narrated in a way that conceals or excludes anything that conflicts with its representation as a forward march. She notes that the conceptualisation of the Anthropocene shares this trait in that it does not engage (or indeed encourage engagement with) what she terms 'the bleak consequences' of further materialisation of current trends. Instead, the focus remains on technological and managerial requirements for living in the Anthropocene. Hartley (2016:157) calls this framing of the Anthropocene out as exemplifying an anachronistic 'Whig' view of history, portraying "history as one endless story of human progress and enlightenment" - one which valorises science, technological advancement and liberal democracy as the signifiers of such advancement, and draws on the foundations of Cartesian dualism and the elevation of reason as the driver of enlightenment (also see Butterfield, 1965; Wilson & Ashplant, 1988; Mayr, 1990).

Steffen *et al.* (2011a:848), in their conceptual and historical review of the Anthropocene, refer to the "evolving social and political structures that unlocked innovative new thinking, and the beginnings of a new economic order that emphasised markets", and frame "the evolution of humans and our societies from hunter-gatherers to a global geophysical force" (Steffen *et al.*,

68 Geostories offer more 'tentacular' or rhizomatic accounts of diverse peoples (and social positions) within particular social-ecological relationships across particular time periods (Haraway, 2016). Such accounts include, in one geostory, biological, chemical, geological, ecological, and social accounts of the web-of-life in a particular time-space. Geostories are also speculative, and imaginative - they seek to reclaim moments, movements, ways of being ... that were erased from time, or sometimes, they are generative and engage their accounts to speculate about probable and possible futures (*ibid*).

2007:614). Read in conjunction with their reference to ‘civilized man’ as the driver of the Industrial Revolution, they reveal this bias in the conceptualisation of both what it means to be evolved, and towards their Whiggian view of industrial (and techno-scientific) development. This same bias can be seen in their articulation of markets as a USA-led “system built around neoliberal economic principles, characterized by more open trade and capital flows”; where this new economy is juxtaposed with those “pre-industrial European institutions that contributed to the depression and, indeed to the Great War itself” (*ibid*: 850). While this same system of capitalised industrial development is credited with the accumulated human impacts on the Earth System, the Whiggian bias is nonetheless still very much in evidence in their framing and articulation of human development central to the Anthropocene thesis. Underlying this view of history is a self-referential qualification elevating scientific and technological progress over alternative ways of being which privilege alternative forms of value.

An exciting, but also difficult and daunting task lies ahead of the global research and engineering community to guide mankind towards global, sustainable, environmental management (Crutzen & Stoermer, 2000:18).

Again, we see a limiting of generativity, and epistemicide-in-action⁶⁹ in such accounts. If humans-in-relation are heterogeneous, and industrialised activities (and associated knowledges) are evidencing themselves in a destabilised Earth System, then reclaiming knowledges and relations that enable alternative or reimagined futures become essential. Moore (2016) and Haraway (2016) provide examples of how to do so in critical conversation with geologists and Earth System scientists.

3.4.3.7. A linear narration of technological determinism, consequences and responses

As highlighted by Santos (2007, 2004), teleological narrations of time are imprecise, first because they are by no means universal, and second, because they serve to recast the history of the world in colonial, abyssal and hegemonic terms (also see 2.11.1; Goody, 2006). Hartley points out that the historical conception of mechanical causality, evidenced by dating the Anthropocene as beginning in the 1800s and the technological advancements of those times obscures the “social and relational modes of historical causation” (2016:156). For example, the colonial social relations enabling the Industrial Revolution are invisibilised, as are the ongoing disparities, and contemporary realities of non or marginally industrialised peoples; so too are

⁶⁹ Epistemicide is a term coined by Boaventura de Sousa Santos. Section 2.7 provides a more in-depth account of his arguments around the epistemic eradication of other-than-scientific knowledges.

issues of non-human personhood⁷⁰, non-industrialised relationships with the Earth and her systems, or economic systems and models which seek to bypass industrialised notions of productivity. As argued earlier, what is centralised and normalised within Anthropocentric narrations is a particular, dominantly Eurocentric (and Americentric) view of history, civilisation, industrial productivity, and development which reproduce great divides (Latour, 2004) and abyssal lines (Santos, 2007, 2004).

Unfortunately, as Moore points out, this has resulted in a conceptual drift within anthropocentric discourses between where it began by articulating contemporary risk, into more recent causal explanations of how we arrived at such risks, where causal explanations are premised on teleological narrations of history (2017). The concept was formulated, first within the field of marine biology, and then geological studies, and was focused on carbon accumulation. The premise underpinning the concept is that of atmospheric carbon beyond a particular systemic tolerance. Carbon is the indicator here, and more specifically, the key moment of relevance is a particular threshold of atmospheric carbon. However, since the argument is that the carbon threshold under question is anthropocentric in nature, carbon levels only provide a post-activity type of indicator of impact, and only in regards to one particular variable within one small domain of the Earth System (see, for example, Crutzen & Stoermer, 2000; Steffen *et al.*, 2007). Steffen *et al.* (2007:614) acknowledge that they, “use atmospheric carbon dioxide concentration as a single, simple indicator to track the progression of the Anthropocene”. This acknowledgement makes visible the conceptual drift that has occurred between what has caused the carbon emissions, beyond industrialisation, what the impacts of such relations are, and how to address the imbalance, beyond the management of one small symptomatic indicator of systemic instability, as the concept of the Anthropocene has been taken up in Earth System sciences and associated research and policy spaces⁷¹.

3.4.3.8. Globalising perspectives, knowledge-building and interventions

White and Wilbert (2010) propose the notion of ‘technonatures’, leveraging it,

to highlight a growing range of voices ruminating over the claim not only that we are inhabiting diverse social natures but also that knowledges of our worlds are, within such social natures, ever more technologically mediated, produced, enacted, and contested, and, furthermore, that diverse peoples find themselves, or perceive themselves, as ever more *entangled* with things—that is,

⁷⁰ By which I wish to indicate the various and diverse movements amongst various groups of people to claim and confer rights to other sentient beings (whether we recognise them as such or not).

⁷¹ The planetary boundaries work of Rockström *et al.* (2009) lend substance to my argument here.

with technological, ecological, cultural, urban, and ecological networks and diverse hybrid materialities and non-human agencies (White & Wilbert, 2010:6).

And Arias-Maldonado adds, “Anthropocene itself can be said to be a technonature”, (2014:11).

Steffen *et al.* (2011a) offer a range of possible responses to anthropocentric risk. Each of these foregrounds the anthropocentric management of the Earth System in ways which centralise human (specifically ‘modern human’ wellbeing). Dominant discussions in the field include those concerning mitigation, resilience, geo and terra-forming, climate control, and others, and are expressed through discourses about stabilising the system, adjusting to planetary boundaries, or techno-scientific knowledge-building, intervention and control. This is illustrated in the following extracts proposing various response strategies to anthropocentric risk:

Active adaptive management has proven effective in dealing with complexity and uncertainty at smaller levels and might also be effective at the global level. Multi-level and polycentric governance systems show promise of bridging the gap between global problems and local impacts and solutions. An additional—and very essential—challenge is to build early warning systems for changes in the Earth system functioning, so that policymakers can respond in time. ... Finally, the governance community will need to greatly enhance its capacity to assimilate new information commensurate with humanity’s exploding capability to gather both biophysical and socio-economic data and to analyse, interpret and model complex system dynamics. (Steffen *et al.*, 2011:857-858).

Later works more strongly promote notions of Stabilised Earth Pathways, which call for an active stewardship role for humans as managers and generators of systemic stability. Unfortunately, stewardship activities are most often articulated in terms of managing the Earth System (often in productivity terms), rather than managing those relations that have given rise to instability in the first instance. For example, they suggest that:

Creating such a pathway and basis of attraction requires a fundamental change in the role of humans on the planet. This stewardship role requires deliberate and sustained action to become an integral, adaptive part of Earth System dynamics, creating feedbacks that keep the system on a Stabilized Earth pathway (Steffen *et al.*, 2018:3).

In fairness, Steffen *et al.* (2018) do consider three overall responses to the Anthropocene: Business-as-usual (least change), mitigation, or geo-engineering options (most drastic and dramatic interventions) (also see Steffen *et al.*, 2007). However, none of these approaches foregrounds reconstituting relations between and within society. Arias-Maldonado⁷², for example, suggests that,

the Anthropocene calls for an enlightened control of nature, that is, a reflective control of socionatural relations that includes the protection of the remaining natural forms and processes (those that are less affected by social influence and retain a greater appearance of naturalness) (Arias-Maldonado, 2014:12).

⁷² Arias-Maldonado is a political theorist whose work focuses on environmental politics.

Note that Arias-Maldonado does not call for a greater control of human nature here, but a greater, albeit more conscious, control of nature. The focus is on managing relations between Earth System and humanity to preserve human life, and therefore the Earth System itself. Mitigation is framed thus,

The mitigation pathway attempts to take the human pressure off of the Earth System by vastly improved technology and management, wise use of Earth's resources, control of human and domestic animal population, and overall careful use and restoration of the natural environment. The ultimate goal is to reduce the human modification of the global environment to avoid dangerous or difficult-to-control levels and rates of change and ultimately to allow the Earth System to function in a pre-Anthropocene way. Technology must play a strong role in reducing the pressure on the Earth System. ... The amount of and value of economic activity continue to grow but the amount of physical material flowing through the economy does not ... Although improved technology is essential for mitigating global change, it may not be enough on its own. Changes in societal values and individual behaviour will likely be necessary (Steffen *et al.*, 2007:619).

At the same time, although such seminal works foreground techno-scientific approaches to Earth System management and stewardship, they also caution against engaging with systemic challenges in isolation. In their 2011 publication for example, Steffen *et al.* (2011a) strongly critiqued approaches which sought to bypass actively reducing especially carbon emissions, speculating on increasingly systematic risks arising from interventions such as carbon-bonding aerosol dispersal as a means of carbon capture. "A strongly contrasting approach—in many ways the antithesis of geo-engineering—is the planetary boundaries concept introduced by Rockstrom and colleagues", they noted (*ibid*:860). They consistently caution against geo-manipulation strategies, which they point out, tend to address specific indicators, rather than addressing systemic impacts. Carbon sequestration strategies, for example, remove carbon, but do not rebalance or replace the systemic Earth System functioning of a functional carbon cycle; they also give rise to potential enormous geo-political consequences (Steffen *et al.*, 2011b).

However, Hartley (2016) flags the technocentric nature of anthropogenic discourses, and especially solutions posited towards mitigating anthropogenic impacts. He challenges that this is precisely because the Anthropocene is framed as deriving from technical roots. This, he claims, leads to the privileging of managerial technologically-oriented solutions (*ibid*). The dominant framing of the Anthropocene by Earth System scientists offers mainly an understanding of industrially-caused risk, and knowledge production which is primarily techno-scientific in nature, and which intends to primarily make more sustainable the industrial and

economic, capitalocentric model of the moderns⁷³. This tends to maintain the foregrounding of [sustainable] development and primarily capitalist, industrialised economy as the central points around which social life is organised. Social-ecological risks are reduced to enclosed environmental risks which are measured against, and tempered by, economic productivity and risks to economic stability and human wellbeing (even if 'human' refers primarily to industrialised societies). This scientific logic serves to obscure tensions between global and local priorities, and masks political and ontological privileging and dominance.

3.4.4. Leveraging a Post Abyssal Notion of Capitalocene

Arias-Maldonado summarises the complexity inherent in the notion of the Anthropocene in ways which generate greater possibilities for 'thinking' social-ecological risk:

the term Anthropocene denotes two different, albeit complementary, meanings. On the one hand, it is a period of time, one that, according to an increasingly large number of natural scientists, should be recognised as a new geological epoch. This is so because of the events that take place within it. But those very events, that may be summed up in the anthropogenic transformation of nature at a global scale, leads us to use the term in a different way: as an epistemic tool. In other words, the Anthropocene is both (i) a *chronology* that, by comprising a number of processes and phenomena whose common feature is the anthropogenic influence on the planet, ends up designing as well (ii) a given *state* of socionatural relations. What the science behind the notion suggests is that natural and social systems are coupled and the extent of the anthropogenic influence on ecological systems and natural processes is unprecedented ... Climate change is the most spectacular outcome of this shift, but it is far from being the only one—disappearance of pristine land, urbanization, industrial farming, transportation infrastructure, mining activities, loss of biodiversity, organism modification, technological leaps, growing hybridization are also on the list. Thus, it is a quantitative shift that constitutes also a qualitative change. Or rather it is the human *realization* of a change undergone some time ago ... it has a given name and scientific validation to a shared intuition about the state of socionatural relations and nature itself (Arias-Maldonado, 2014:3, emphasis in original)

Barry and Maslin resonate, pointing out, "the Anthropocene is inherently a political concept; it enlarges the scope of what we take to be the politics of the Earth" (Barry & Maslin, 2016:2). Arias-Maldonado adds (2014:1) "the coming of the Anthropocene, both literally and epistemologically, does not constitute the final conclusion of any conversation, but the starting point for one". Understanding this, Barry and Maslin question,

is it appropriate to arrive at a *specific* date for the start of the Anthropocene, given that the concept is intended to capture the effect of a series of different dynamics, which operate over various time-scales? ... After all, whatever capitalism is taken to be, there is no singular marker for its beginning. Likewise, whatever the Anthropocene is, it is surely the product of multiple geological dynamics and historical trajectories (Barry & Maslin, 2016:5, emphasis in original).

⁷³ it should be noted that there is recognition of uncertainties around this logic in the recourse to complexity theorising.

As signified earlier, Moore identifies two narrative strategies tied up in the Anthropocene discourse that underpin its problematic. The first is that consequences determine periodisation, and the second that the anthropos is the driver of these consequences. Instead, Moore, an historical environmentalist and geographer, argues that the term 'Capitalocene' provides a more accurate description. For him, "the Capitalocene signifies capitalism as a way of organising nature - as a multispecies, situated, capitalist world-ecology", and of privileging those hegemonic relations that enable the ongoing accumulation of capital (Moore, 2016:6).

Capitalocene names capitalism as a system of power, profit, and re/production in the web of life. It thinks capitalism as if human relations form through the geographies of life. Far from refusing the problem of political economy, however, it highlights capitalism as a history in which islands of commodity production and exchange operate within oceans of Cheap - or potentially Cheap - Natures. ... It also works — and this is less widely understood - by elaborating forms of power, re/production and rationality that mobilize work in service to capital, but outside profit/loss accounting (accumulation by appropriation) ... To these I would add the extra-economic movements of empire, science and culture that seek to control and dominate — but not commodify directly or wholly — relations of human and extra-human work (Moore, 2017:606).

The Capitalocene is concerned with extended forms of power (territorial, intellectual, ontological, and otherwise) that formed in support of the ongoing accumulation of capital; it provides a more expansive relational view of the cultural-historical causes of the contemporary social-ecological crisis in that it takes account of formative and functional processes, systems and relationships that underpin the consequences and impacts brought to the global agenda by Earth System scientists' version of anthropocentric risk. Within anthropocentric circles, Lewis and Maslin similarly propose a geo-historical argument in favour of defining the start of the Anthropocene in relation to what they more neutrally describe as the connection of the two hemispheres (in modern terms) into a global system (2015). They propose what they term as the 'Orbis hypothesis' and the 'Orbis spike', which provides a more coherent geological indicator of carbon as a more appropriate start point,

because post-1492 humans on the two hemispheres were connected, trade became global, and some prominent social scientists refer to this time as the beginning of the modern 'world-system' ... The impacts of the meeting of Old and New World human populations—including the geologically unprecedented homogenization of Earth's biota—may serve to mark the beginning of the Anthropocene. Besides permanently and dramatically altering the diet of almost all of humanity, the arrival of Europeans in the Americas also led to a large decline in human numbers ... Numbers rapidly declined to a minimum of about 6 million people by 1650 via exposure to diseases carried by Europeans, plus war, enslavement and famine (Lewis & Maslin, 2015:175).

The choice of .. 1610 ... as the beginning of the Anthropocene would probably affect the perception of human actions on the environment. The Orbis spike implies that colonialism, global trade and coal brought about the Anthropocene. Broadly, this highlights social concerns, particularly the unequal power relationships between different groups of people, economic growth, the impacts of globalized trade, and our current reliance on fossil fuels. The onward

effects of the arrival of Europeans in the Americas [and other colonies in Africa and Asia] also highlights a long-term and large-scale example of human actions unleashing processes that are difficult to predict or manage (Lewis & Maslin, 2015:177).

This modernist periodisation currently excludes accounts of the first great human migration from Africa across the globe, and the related destruction of many large mammal species, bearing in mind that this earlier great migration would remain uncoupled from Capitalism. The European migration in pursuit of wealth and resources called for specific organisations of knowledge and production geared towards facilitating commodification and accumulation of capital; and knowledge systems concerned with the accumulation of capital that prizes dualism, separation, and mathematisation (Moore, 2016). Fundamentally, it provided a machinery for warranting a 'new way' of seeing and ordering reality that is characteristic of contemporary modernity and capitalism in the broader sense, establishing Santos' abyssal line. Refining this argument further, McBrien (2016) unearths the systematic conceptual exclusion that Capitalism is premised on, and brings to the fore the implications of such exclusion on both biodiversity (in the form of extinctions), and on the exclusion and extinction of whole ontologies and epistemologies that cease to exist as the cultures and languages within which they are contained are exterminated. According to McBrien, modern science itself enacts capitalist forms of systematic exclusion in the ways in which it operates and legitimates (*ibid*). These arguments resonate strongly with those leveraged by decolonial thinkers, as outlined in 2.7.

3.4.4.1. 'The rise of cheap nature'

Fundamental to capitalist social relations, is the ontological and axiological construction of 'cheap nature'. For Moore (2016, 2017), Hartley (2016), and Altvater (2016), the secondment of what they term 'cheap nature' is of paramount significance in coming to an understanding of our current global context of social-ecological risk. Moore identifies four 'cheaps': food, energy, raw materials, and human life, to which I add a fifth which includes other biological species (also see Dasguptaa, 2021). Moore's argument traces the 'new pattern of environment-making' stimulated by the rise of a capitalist economy. At the root of this reconfiguration was the shift from land to labour productivity, and the accompanying devaluation and appropriation of other forms of activity in support of labour productivity (and its' processes of commodification). Central to the idea of 'cheap nature' are concerns over whose, and which work is valued, and which lives matter. In other words, the concept of 'cheap nature' provides an axiological foundation upon whose basis value is rationalised. It provides the foundation upon whose

premise the praxis of both accumulating and organising bodies (including human and other-than-human), and assigning them value, is rationalised. As evidenced in Chapter 7, there is a danger of citizen science contributions being designated into the category of 'cheaps'.

For Moore (2017, 2016), Hartley (2016) and Altvater (2016), 'cheap nature' denotes the work/energy and biophysical utility which is produced with minimal labour-power, but which is directly implicated in the production and exchange of commodities, and leveraged towards the accumulation of capital. This is accomplished in three moves of particular significance: 1) through the Cartesian adoption of dualism between humanity and nature; 2) the construction of humans at the centre of the web-of-life, and dominant within it, and 3) through the re-allocation of most humans into nature (Moore, 2016). These three aspects require ground-clearing in order to engage a more coherent post-abyssal epistemic expansion. The first and third were been engaged with in critique 1, and in 2.7, all three are re-addressed briefly below.

3.4.4.2. Cartesian dualism, Capitalist productivity, and social-ecological relations

The biggest failing of the Earth Systems scientific construction of the term 'Anthropocene', according to Moore, is that it retains in its ideology and through the many areas of work in which the term has been taken up, the binary of nature and humanity, rooted in Cartesian dualism (2017, 2016; Latour, 2004; also see earlier critiques in this chapter). The epistemic implications of such a dualist view of the world both poses analytical barriers, as well as reproduces 'real world' systems of appropriation, exploitation and domination (Moore, 2017:601). As already argued, the foregrounding of dualistic approaches as ways of seeing and organising the world act to obscure the iterative, integrated and interrelated relationships between things. It obscures that human bodies, cultures, systems and organisations are in fact co-constituted in-and-with-nature, and that this becomes invisible, and what is foregrounded are the differences between humans and nature, mind and body, body and soul (or the metaphysical). Moore reminds us that:

[n]ot only does human activity produce biospheric change, but relations *between* humans are themselves produced in and through the web of life. Nature operates not only outside and inside our bodies (from global climate to the micro-biome) but also *through* our bodies, including our embodied minds. Humans produce intra-species differentiations which are *ontologically* fundamental to our species-being (Moore, 2017: 603, emphasis in original).

And Haraway adds that,

No species, not even our own arrogant one pretending to be good individuals in so-called modern Western scripts, acts alone; assemblages of organic species and of abiotic actors make history, the evolutionary kind and the other kind too (Haraway, 2015:159).

Moore argues that this form of dualism is granted ontological standing, rather than being recognised as an historical ideological construction - we forget that this view is a human ideology of organisation, and see it as a feature of reality instead, thereby rendering it invisible, and its implications natural (*ibid*). And it is through this ontological rift, that Moore claims Capitalism is operationalised because within it lies significant thought structures underpinning our view of modernity. This ontological rift is constituted through four propositions:

- a) the imposition of ontological status onto entities (or things), rather than relationships;
- b) the privileging of either/or logic that dualises and differentiates;
- c) the centralisation of human control over nature through applied science; and
- d) the privileging of the visual as the primary conduit for knowing the world (2017:605).

To reframe Moore's argument in other words, Cartesian dualism enabled us to make distinction between humans and 'things', to isolate them from the relationships within which they are embedded, to know 'things' primarily through visual engagement, and finally, to assert the right of man [sic] to control 'things' / nature. Other critiques of modern philosophy and systems of Capitalism resonate strongly here, including Bhaskar's Critical Realist arguments (2008), and Santos' work (2016, 2007, 2004; also see 2.9).

3.4.4.3. The reallocation of most humans into nature

An historical account of social-ecological risk brings into view the patterns of appropriation which underlie and enable the conception of 'cheap nature', including historical and contemporary patterns of relocation (moving some humans and other-than-humans off their lands and appropriating these territories into colonies), coupled with the re-designation of these humans into nature (based on processes of rationalisation which distinguish them as 'other', 'less than', 'without souls', and other ways of morally negating the 'other') (see 2.9). The historical move to delegitimize these groupings of humans as part of what is considered as Humanity served to create the human 'cheap' - a labour force without the rights afforded to the rest of Humanity, and who could, themselves, be traded and treated as commodities, or at the very least, as illegitimate within the labour market, and therefore as cheap sources of unpaid labour outside of it. Among the excluded were - and in many cases, still are - women, indigenous communities, and various class and ethnic groups. With the delegitimisation of these groupings came the delegitimisation of their knowledges and ways of being, and the moral justification for appropriation of resources and bodies with their social-ecologies (Santos, 2004; also see 2.9).

Fundamentally, Moore's argument is focused on how relationships between people, and between people and the other-than-human world shifted in order to facilitate the accumulation of capital (2017, 2016). While a key and powerful moment in this shift was certainly the Industrial Revolution of the 1800s, Moore argues that the reconstituting of relationships whose outcome was the Industrial Revolution, did not begin there. At the centre of this relational transformation was the reconstitution of Nature (with a capital N) to include the vast majority of humans on the planet (women, indigenous peoples, large groups of enslaved peoples, and many 'white-skinned' men such as Jews and Irishmen, etc.) (Moore, 2017, 2016; Santos, 2009; 2007, 2004). This relational shift enabled a set of quite specific ideological moves that enabled Nature to be used in a wider range of exploitative activities related to the accumulation of capital, and legitimated the appropriation of ever-larger spheres of uncapitalised nature as low-cost streams of work (Moore, 2017, 2016). Moore levels a charge of naturalising "inequalities, alienation, and violence inscribed in modernity's strategic relations of power and production", noting that the dominant Earth System science conceptualisation of the Anthropocene does so by maintaining an abstract view of human activity within the web-of-life (Moore, 2016:82).

3.4.4.4. Rationalised commodification

Building on McBrien (2016) and others, Altvater adds to the stock of conceptual limitations underpinning notions of the Anthropocene by outlining the processes of rationalisation that are enacted through the procedural accumulation of capital (2016). He draws our attention to the challenge of accounting for the many contributions to the capitalist project, reminding us that, "many interdependencies in society and nature *cannot be expressed in terms of prices*" (emphasis in original) (2016:151), and that their exclusion from the 'books' is based on specific processes of rationalised exclusion and ontological re-designation (also see Moore 2017, 2016; Santos, 2009, 2004; Latour, 2004). Parenti (2016) takes the argument of commodification further, articulating both the formation of capitalist states and institutions, and their processes for accessing, regulating and controlling cheap nature. He draws our attention to the processes of measurement, understanding, representation, containment, and military, legal and scientific control which are required to enact the regulation of specified terrains and their natures. Parenti highlights that this is a key process of secondment of nature to the service of commodification and the accumulation of capital (*ibid*). He labels these processes as constituting biopower and geopower (the technologies and statecraft which make biological and geological features accessible, legible, knowable and utilizable towards the accumulation of capital). Here, we once

again see the translation of 'cheaps' from commons and common goods into public administrations and public goods, and the articulation of systems of knowing and coming to know, which are likewise translated into hegemonic systems which serve to reinforce such hegemony. Hartley (2016:165) reminds us that we need to go beyond responding directly to those ecological impacts that directly threaten our human wellbeing,

we must also attack those elements of capitalist civilization *which appear to have no immediate relation to ecology, but which are in fact internal conditions of its possibility*: violence against women both literal and symbolic, the structural obscurity of domestic labor, institutional racism, and so on. At its outer limit, ecological struggle is nothing but the struggle for universal emancipation (emphasis in original).

While this thesis is not concerned with the Capitalism vs Socialism debate, the perspective offered by the notion of Capitalocene does serve to more coherently account for the historical formation of the contemporary social-ecological challenge, most particularly in that it makes visible the ontological implications of this historical formation, and its epistemological and axiological consequences. As Moore points out,

To locate modernity's origins through the steam engine and the coal pit is to prioritise shutting down the steam engines and the coal pits, and their twenty-first century incarnations. To locate the origins of the modern world with the rise of capitalism after 1450, with its audacious strategies of global conquest, endless commodification, and relentless rationalization, is to prioritize a much different politics - one that pursues the fundamental transformation of the relations of power, knowledge, and capital that have made the modern world (Moore, 2016:93).

While Moore (2016), Hartley (2016) and others referenced above attribute the origins of the ecological crisis to the rise of Capitalism, I suggest that it might be more accurate to say that Capitalism is a significant contributor to our current social-ecological entanglement; I am not sure that it is the absolute root of the crisis - simply that it is so ubiquitous, and impactful on the global system, that it needs to be taken seriously, and at the very least considered to be a key driver and enabler of the contemporary state of the Earth System and its resident web-of-life. Capitalism, its processes of historicising, and its contribution to the constitution of the Abyssal Line, provides a wall behind which human systems and relationships become more obscure - less easily outlined or relatable. The modernist capitalist worldview is so pervasive so as to obscure other geostories, while at the same time also becoming largely invisible and normative through its pervasiveness - and so taking account of the capitalist system (both in terms of its historical formation, and in terms of its accumulated impacts), is an important starting point to engaging with the social-ecological crisis more rigorously, and especially in an attempt to

become more self-reflective, reflexive and response-able participants within a post-abbyssal framing of the web-of-life.

The implication of this framing on work attempting to respond to the contemporary social-ecological challenges is that we need to engage with those ideological, hegemonic and normative processes that act to legitimate the reproduction of relations which are unsustainable, and irreconcilable with alternative ontologies within the web-of-life. This leaves us with questions of how to redress systems of commodification, capitalisation and appropriation, in ways that respond to social-ecological risks and riskiness. It also expands the realm of legitimate epistemic activity, and centralises a role for epistemic, contributory and distributive justices.

3.4.5. Anthropocene, Capitalocene, and Envisioning and Generating Alternatives

Read together a range of authors challenging dominant conceptions of the Anthropocene produced by geological and Earth System sciences, raise the need for what Moore describes as “an ontological imagination beyond Cartesian dualism, one that carries forth the possibility of alternative valuations of food, climate, nature, and everything else” (2016:11). Crist specifically challenges us to recognise that there is more at stake than the extinction of our species, imploring “that our survival as a species may be in jeopardy is a concern shared by all, but is not *who we are on Earth* also of paramount significance?” (2016:23, emphasis in original). Haraway seems to acknowledge that the Capitalocene is a better lever for articulating the ‘muddle’ that is the contemporary social-ecological crisis, although she does not advocate remaining in the Capitalocene, but rather thoughtfully co-constituting a new era (perhaps a tentacular, knotted Chthulucene⁷⁴) that re-situates, re-examines, and enables new and old choices and socio-material relations (2016, 2015). These authors, among them, outline a range of thinking tools and processes to take our thinking beyond these limitations, and start us on a journey towards invigorating more inclusive post-abbyssal onto-epistemic imaginaries (see 4.5) in the service of social-ecological relations which foreground the common good. How might we expand beyond what is currently conceptualised in ways that are generative, justice-enabling? And importantly for this research, what are the implications for generative epistemic knowing-doing in response

⁷⁴ Chthulucene is a phrase used by Haraway (2016, 2015). The word is derived from the Greek word chthonic, meaning earth, and is associated with creatures that dwell in or under the earth. Haraway leverages the term to indicate a process of reworlding the world through a process more akin to composting than posthumanism. Such a process collects the wastes of the Anthropocene and reforms it into something that enables new life.

to social-ecological risks which both restore commons and help us to generate the capacities to common? Below are is a synthesis of onto-epistemic invitations.

1. 'Anthropocene' is a limited disciplinary term, requiring translation into other arenas

First, it is useful to remind ourselves that the concept of the Anthropocene refers to the first *empirical, geological* evidence of anthropocentric activity *at the scale of the Earth System as a whole* (rather than localised scales). The term references a specific, *disciplinary* articulation of impact, and requires careful inter-cultural translation before it can be usefully leveraged within a broader epistemic context. Appropriation of the term into other epistemic spaces is incoherent without careful translation, and indeed, maintains its contentious nature whenever it is leveraged without its epistemic context made transparent. As Barry and Maslin remind us,

To be able to discuss and translate the new scientific concept of the Anthropocene, it needs to be defined. But which definition is taken will make a clear geopolitical statement; was it Neolithic farmers and deforestation, colonial expansion and the globalisation of biota, the industrial revolution and the use of fossil fuels, modern medicine and the great population explosion, capitalism and consumerism, or the development and testing of nuclear weapons that has accelerated and threatens planet-wide destruction? (Barry & Maslin, 2016:6).

If they are to be accepted, accounts of the Anthropocene have to be understood as constructs of historically contingent forms of scientific practice, not merely as *social* constructs or ideological projections (Barry & Maslin, 2016:7, from Stenger, 2010, emphasis in original).

In this study, this calls for recognition of both the use of hegemonic conceptualisations of social-ecological risk (where present), and the need to re-orient such concepts into locally-referenced and rooted translations.

2. We need to clearly differentiate 'evidence of impact' from 'causes of impact'

Secondly, *evidence of impact* cannot be conflated with *cause of impact* - therefore the use of the term Anthropocene *to describe causal features is imprecise*. A term that can be coupled with 'Anthropocene', but which also signifies causality, is needed to avoid any connotations of causes and effects of anthropocentric activities. Alternatively, other terms, whose function is to denote causality are required. Causes require greater specificity and engagement with the social-ecological-cultural-milieu, and require an active resistance to homogenising notions of anthropoi, social impacts, ontological and epistemic descriptions and historical timelines. In causal articulations, the relational nature of social-ecological risk should be foregrounded - relationships become more significant than any single variable or measurable shift in geobiochemistry. Knowledge production informing intervention into context needs to arise from, and be generated through a relational perspective. Chthulucene (Haraway, 2016, 2015),

Capitalocene (Moore, 2017, 2016), Europocene, and other such terms have already been offered - they begin us on a path of generating, renewing and (re)imagining alternative narratives to describe the relations between humans, the web-of-life and the Earth System of which we are a part. While this form of post-abysal expansion falls beyond the scope of this study, it is relevant for re-thinking epistemic priorities, and expanding the criteria used to determine ongoing epistemic design.

3. Relations require reconstitution

As argued from the onset of this dissertation, social-ecological relations require reconstitution within epistemic work, both from epistemic and distributive justice perspectives, and in terms of redressing the ontological dissonance emanating from diverse enactments of Cartesian dualism. Crist, Haraway, Moore and others, between them advocate ways of thinking, learning and relating to the world that foreground relationships - "ways of thinking that connect first, and separate later" (Moore, 2017:599). This requires a reconstituting of relations across our epistemic systems, rather than at the point of response; ontologies, and their arising epistemologies and axiologies, together, require greater rigour. The use of ecologies of knowledges, and the methodological foregrounding of political rigour are two mechanisms used to enable this form of post-abysal expansion in this study.

4. Hegemonic histories and narrations of human-nature dualities require re-articulation

To move into an epistemically generative mode, we need to recognise the limitations of scientifically legitimated histories as partial and hegemonic in nature, and then conceptualise those alternatives that enable us to account for ourselves as a diversified, heterogeneous species who have related to, and continue to relate to the Earth, Earth System, web-of-life, and other humans in diverse ways. Histories are dominated by the hegemonies masking the gross injustices and practices of enslavement and appropriation of Eurocentric colonies and colonial ways of being - they are not so much an account of human activity, but rather, more often, a moralised account of justified appropriation, superiority and 'civilisation'.

Is it possible ... to construct a non-Eurocentric account of the Anthropocene? ... rather than offer a singular account of the Anthropocene, might it be possible to address the ways in which all analyses of the Anthropocene are inevitably, or necessarily, partial? (Barry & Maslin, 2016:7-8).

Articulating geostories, Gaiastories⁷⁵, sym-cathonic⁷⁶ stories, and other types of stories (Haraway, 2016), instead of hegemonic histories, provides a stronger way to frame and understand anthropocentric effects. Reclaiming relational stories, with their contestations, complexities and rhizomatic entanglements offer us stronger service in work intended to respond to and resolve social-ecological risk and riskiness. They offer an opportunity to reclaim deeper justices, and make stronger kinships (Haraway, 2015). Haraway (2016) argues that the telling of histories (the stories of human exceptionalism, which hide the exclusions, genocides and biases of the mainstream discourses of the Anthropocene) need to be replaced by the narrating of geostories, Gaiastories, and sym-cathonic stories - stories that narrate messy, not yet completed, uncertain, changing relationships across time. In this study, this form of post-abyssal expansion is started through the use of ecologies of knowledges (Santos, 2007, 2004).

5. Reclaiming our position within the web-of-life

Reclaiming our position within the web-of-life, as part of the web-of-life shifts the possibilities for kinship - both within our own species (think of all of those epistemologies that might be reclaimed as legitimate social experience (Santos, 2004)), and with all others. Haraway (2016) argues that this opens up the possibility for asking situated questions among kindred of all kinds (2016, 2015). In this, she resonates with Crist (2016) drawing on Berry (2008), who outlines a vision for an ecozoic - a vision in which humanity is part of nature, and which embraces 'union in diversity' - here, humanity is part of the wider community-of-life. This calls for the formation of appropriate boundaries, and for "living in integrity in the biosphere" (*ibid*: 28). This form of post-abyssal expansion has bearing in this study because it provides an expanded reference for defining social-ecological risks, and epistemic priorities in relation to them, and to reframe dualist sorting which privileges human well-being over other forms of life.

6. Moving beyond deficit-based accounts of human/web-of-life, human/Earth System

Unfortunately, both the conceptualisations of the Anthropocene and the Capitalocene provide a deficit-based narration of the relationships between humans and the rest of the web-of-life, and

⁷⁵ Gaiastories are 'speculative fabulations' or stories that transform anthropocentric mindsets, and instead, reposition ourselves in nature, and embrace all the inhabitants of the Earth, and the Earth herself. For more on speculative fabulations, listen to Haraway here: <https://youtu.be/K1atjLfbNxE?list=TLGGhYtEDQ3BI7cyNDAYmJAYMQ>

⁷⁶ Sym-cathonic, (from sympoiesis-cathonic) is a hybrid notion leveraged by Haraway to bring together a relational ontology - a relational enactment of being within and with the Earth, in kinship with all the 'critters' and the Earth herself. It privileges relation over substance. It is also generative in nature, relaying relations between living and dying, waste and recreating (Haraway, 2016).

between diverse groupings of humans. What are the possibilities for evidencing, reclaiming and reconstituting other types of relations? Collaborative relations, concerned relations, creative relations, consciously inter- and intra-connected relations, reimagined relations, restorative relations, participatory relations, mutual and symbiotic relations, responsive and responsible, honourable or reverent relations. Enactments of these and many other forms of relations are being enacted to varying degrees across all societies. Which generative openings do they offer us? Which epistemic insights and ways of knowing do they enact, or might they enact?⁷⁷ What can they teach us to equip us in our work of reconstituting relations?

7. Increasing response-ability

Can we increase response-ability (without deferring our various responsibilities) through the conscious mobilisation of ecologies-of-knowledges and ecologies-of-practices? Haraway (2016) advocates the cultivation of response-ability, which is also 'collective knowing and doing', what she (and Latour, 2004) consider an ecology-of-practices. Response-ability, according to Haraway, calls for reflexive thoughtfulness, and conscious presence towards what we choose to perpetuate. Cultivating response-ability, she notes, "requires the risk of being for some worlds rather than others and helping to compose those worlds with others" (*ibid*:66, footnote 27). Part of this task for Haraway, is the creation and recreation of sanctuary. For me, this includes learning to common, and generating conscious commons, where we can practice and collaborate on generating sanctuaries of all sorts, across diverse scales.

One way to live and die well as mortal critters in the Chthulucene is to join forces to reconstitute refuges, to make possible partial and robust biological-cultural-political-technological recuperation and recomposition, which must include mourning irreversible losses (Haraway, 2015:160).

I think that Haraway is not referring to frantically holding on to what has been framed as sanctuary (conservation areas, bio-reserves, cultural-reserves, artificially stabilised economic models that protect some while evicting all others, and others); I think she is calling for sanctuary-building in ways that are relational - in ways that expand the possibilities for safety, wellbeing and (re)newed expressions of life. What do governments and scientific institutions who take as their work, sanctuary-building look like? Which forms of knowledges must we build? Which forms of commoning require articulation and enactment? This post-abysal expansion and the previous one, together, provide a way to re-reference human- web-of-life relations.

⁷⁷ Chapter 7 provides an empirical account of some of these enactments within the field of practice in the citizen sciences.

Within citizen science projects, this includes questioning pre-defined positioning of communities in relation to other species or Earth systems, and recognising that those relations are multiple, and co-constructive, even if they are also sometimes risky and troublesome. Many people engage in citizen science activities as a form of sanctuary-building and as a way of reconstituting their relations. Chapters 5, 6 and 7 highlight this tendency among citizen scientists.

8. Envisioning futures

While the work of reframing our current understandings of social-ecological risk, as well as evidencing and responding to such risk, is undoubtably important, Heikkurinen *et al.*⁷⁸ (2020) challenge us to also stretch our onto-epistemic imaginations (see 4.5) into times and spaces beyond the Anthropocene. They acknowledge that while contemporary experiences and concerns,

certainly deserve consideration, effort should also be aimed at questions of how the Anthropocene might come to an end (as a discourse and as an epoch); what post-Anthropocene might look like; and what this might signify for organizing social change, and/or caring for the nonhuman nature ... sustainability scholarship should begin imagining a time after the Anthropocene, when humans would no longer be the dominant species on the planet, and think of how to move there (Heikkurinen *et al.*, 2020:1-2).

And Haraway adds,

I think our job is to make the Anthropocene as short/thin as possible and to cultivate with each other in every way imaginable epochs to come that can replenish refuge. Right now, the earth is full of refugees, human and not, without refuge (Haraway, 2015:160).

What would life after the Anthropocene be like? How can we begin to enact that future in this present? In this context of this study, this post-abyssal expansion is attended to through various enactments of political rigour, which offer deeper engagement with social-ecological risks and the epistemic cultures emerging in response to them. Re-aligning the purpose of common knowledge production towards the common good enables the development of collective capabilities to reconstitute collective futures.

9. Regenerating, re-establishing and re-constituting epistemic integrity and rigour

How do we conceive of forms of rigour which help us to go beyond the current systems of dualistic rigour? Which forms of integrity are available to guide us in this work? For me, the task is to develop epistemic practices that begin to make visible the powers and politics through which knowledge is being produced, and through this, to begin to re-imagine the world we seek to inhabit, and the nature of the Anthropoi who are best suited to both bring about, and

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inhabit such a world. Arising from the insights generated through this research, I've begun this work of articulating more coherent forms of rigour in Appendix 11. There, I begin the work of articulating all the gaps in rigour that have become visible through this research process.

10. Generating relational praxes of knowledge production-learning as commoning

Finally, bringing the focus squarely back to the goal of knowledge production as commoning, in response to social-ecological risk, we arrive at the need to (re)imagine, (re)formulate, and (re)constitute knowledge production activities which support us in recovering our relations, and generating (re)newed relations. How do we generate relational praxes of knowledge production-learning which make kin, create and sustain sanctuary, and restore to us, our commons? Latour reminds us that, "research does not deal with nature or knowledge, with things-in-themselves, but with the way all these things are tied to our collectives and to subjects", (1993:4), or if it does ... if our enactments of research - of coming-to-know - have become about knowing things-in-themselves, perhaps it doesn't have to be so going forward.

Our current social-ecologically risky global context calls for a different form of knowledge production, research activity and educational imperative - one that accounts for the relational complexities of both the historical and contemporary social-ecological crisis. It calls for us to take stock of the unattended consequences of our contemporary ways of being and doing. But it also calls for more than accounting, detailing and evidencing all the different ways we have been enacting relations with and within the web-of-life - it calls for the generation of onto-epistemic imaginaries which enable us to more consciously choose new relations for ourselves.

[M]ake kin, not babies! It matters how kin generate kin (Haraway, 2015:162).

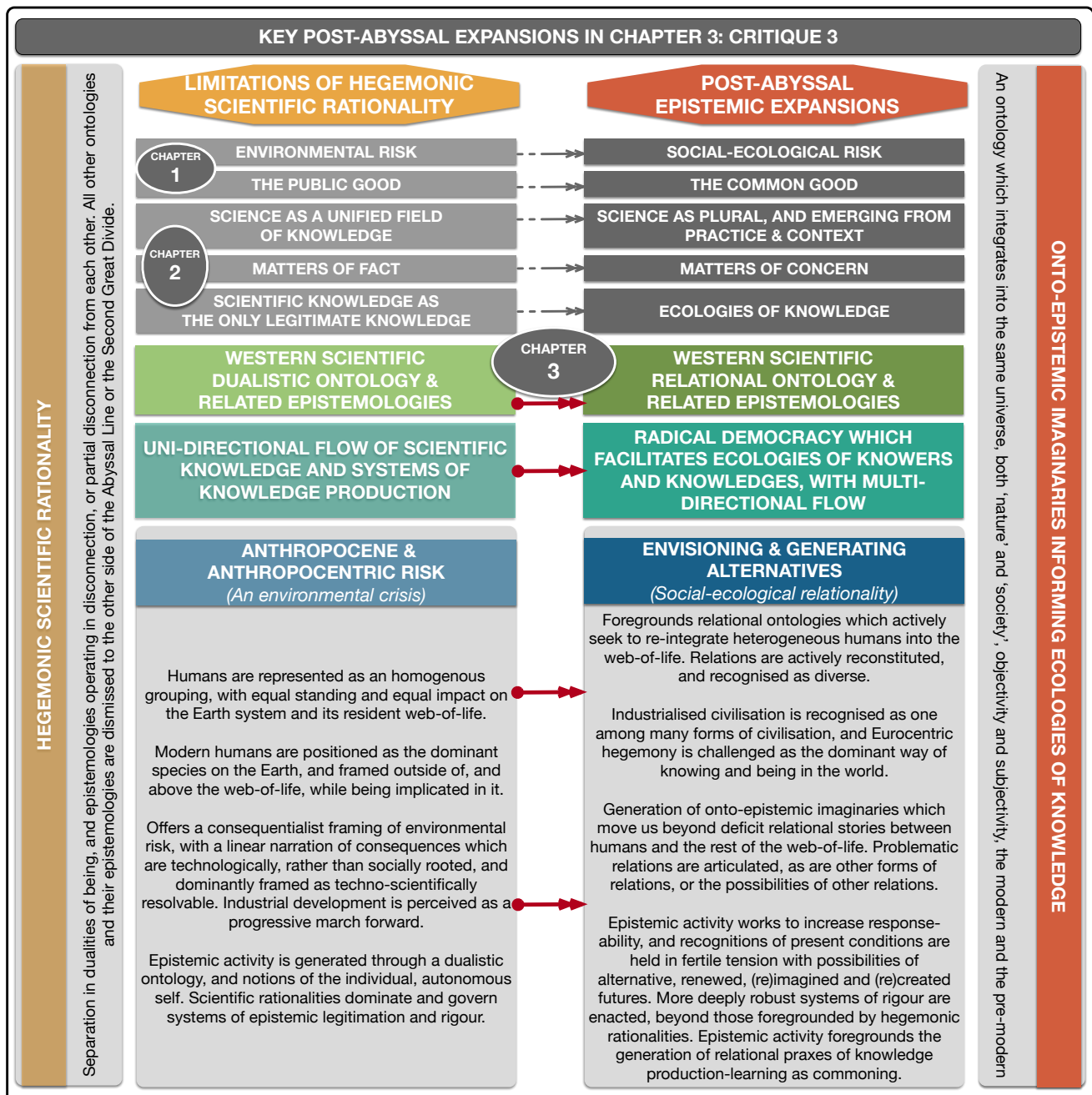


Figure 15: Visual summary of post-abyssal expansions in Critique 3

Chapter Conclusion:
(Re)framing, (Re)claiming
and (Re)constituting
Epistemic Activity

3.5. (Re)framing, (Re)claiming and (Re)constituting the Way We Build Knowledge

The critiques offered in this chapter are beginnings - they emerged in light of contradictions I encountered within the citizen science field of practice, between those responding to social-ecological risks on the ground, and those responding to those same risks within the institutional triads of science, policy and governance systems. These critiques helped me to account for why the gaps between institutional (and institutionalised) systems and citizens working to generate commons of various kinds arose. The three critiques provide windows into prevalent knowledge cultures, and starting points for the work of (re)framing, (re)claiming and (re)constituting the rich knowledges being produced through the epistemic cultures of citizen science projects. For me, what has become evident are the deep injustices, epistemicides and erodings that are being perpetuated through dominant modernist scientific ways of legitimating and warranting knowledge. The three articulations of knowledge cultures evidence a mutually reinforcing nexus of ideas, methodologies and policy implications which perpetuate produced nonexistence. The critiques provide a range of criteria that we can use to read literature and reporting for produced nonexistence. These criteria are summarised below, and have been used to 'read' the body of citizen science literature presented in Chapter 5.

In the first critique, I troubled the dualistic ontological foundations used to legitimate and warrant knowledge, and considered how such dualisms might viably be overcome. The critique brings to the fore, the epistemic injustices perpetuated via dualistic forms of rationality, and the mechanisms of dualistic sorting used to enact such rationality. Recognising and acknowledging dualistic underpinnings of modernist scientific epistemologies enables us to reach for more coherent ontological framings on which to establish our epistemological work. If we are using a dualistic system of warranting knowledge, which foregrounds western science and diminishes all other ways of knowing, then it is unsurprising that other knowledges are rendered invisible and unviable unless they are reconcilable with such a science.

EVALUATIVE CRITERIA FOR PRODUCED NON-EXISTENCE EMERGING FROM CRITIQUE 1

• Dualistic sorting sorts epistemic activity into privileged and denigrated categories (Nature/Society; Objective/Subjective, etc.) (3.2.1.) • Enactment of either of Latour's Great Divides (3.2.2.)	• Denigration of pre-modern knowledges and privileging of modernist approaches to scientific knowledge production (3.2.2.)

• Production of 'matters of fact' (2.7; 3.2.2), which are enacted through the following: <table border="1"> <tr> <td> ▸ Invisibility of scientists in their facts; ▸ Instrumentalist articulation of facts, divorced from causes; ▸ Facts presented devoid of their contexts of production; ▸ Processes of mediation are rendered invisible; </td> <td> ▸ Society pole bears full responsibility for explanation, while facts stand by themselves; ▸ Suppression of particular kinds of relationships as scientifically illegitimate; ▸ Rejection of unified or relational ontologies; ▸ Clear distinction between premoderns (who work contextually) and moderns (who work universally) </td> </tr> </table>		▸ Invisibility of scientists in their facts; ▸ Instrumentalist articulation of facts, divorced from causes; ▸ Facts presented devoid of their contexts of production; ▸ Processes of mediation are rendered invisible;	▸ Society pole bears full responsibility for explanation, while facts stand by themselves; ▸ Suppression of particular kinds of relationships as scientifically illegitimate; ▸ Rejection of unified or relational ontologies; ▸ Clear distinction between premoderns (who work contextually) and moderns (who work universally)
▸ Invisibility of scientists in their facts; ▸ Instrumentalist articulation of facts, divorced from causes; ▸ Facts presented devoid of their contexts of production; ▸ Processes of mediation are rendered invisible;	▸ Society pole bears full responsibility for explanation, while facts stand by themselves; ▸ Suppression of particular kinds of relationships as scientifically illegitimate; ▸ Rejection of unified or relational ontologies; ▸ Clear distinction between premoderns (who work contextually) and moderns (who work universally)		

The second critique - science and its publics - brought me to a point of recognising that more robust forms of radical, participatory and deliberative democracy require enabling institutions - generative knowledge production is insufficient if the institutions mediating epistemic activity and the dissemination of such activity, are blind to the ecologies of knowledges being enacted on the ground. Such institutions are currently geared towards articulating scientific knowledge, and therefore promoting such knowledge above all others. Citizen science projects are often situated at the intersection of a number of scientific and state institutions - many without an institutional arrangement of their own, and therefore subject to the epistemic cultures of such institutions. Chapter 7 provides three illustrative examples of such arrangements and their impacts on epistemic activity. In light of this critique, enabling and strengthening the epistemic cultures of citizen science projects requires the reconstitution of the institutional cultures they are connecting with - even before strategies of alignment and articulation (through which they become visible as viable generators of knowledge and risk-responsiveness).

EVALUATIVE CRITERIA FOR PRODUCED NON-EXISTENCE EMERGING FROM CRITIQUE 2	
• Foregrounding deficit, citizen-consumer or shallow deliberative or participatory models of civic science • Dualistic sorting between 'facts' and 'values' • Scientific literacy development as building consensus aligned with State-scientific alliances • Configurations of institutions mediating civic engagement and enactment of citizen science approaches, which are geared more strongly towards the production of modernist science, rather than intervention into context • Homogenous, official or representational publics	• Uni-directional flow of expertise, knowledge and power, from scientists to policy mediators to publics • Role of publics is limited to commenting on or deliberating the 'facts', and engagement with values is deferred indefinitely • Rationalised policy-making approaches (risk is resolved through the production of scientific knowledges) • Modernist institutional cultures which seek to implement deliberative or participatory methodologies (resulting in shallow democracies)

• Focus of participation on data generation, or providing input only at later stages of technological development and implementation	• Knowledge contributions are ranged by scientific systems of legitimation only. • Clean categorisations of expertise, extending to social categories

Critique 3 considers dominant framings of social-ecological risk - especially those drawing on dominant Earth System Science conceptions of the Anthropocene, and the ways in which they lead us towards limited and hegemonically biased epistemic activities in response to social-ecological risk. Again, the argument is geared towards understanding how the complexity of knowledges being generated within citizen science projects are rendered incoherent or nonexistent within such framings. The critique ends with suggestions of how we might reconstitute our conceptualisations of risk, thereby generating stronger, relational epistemic openings.

EVALUATIVE CRITERIA FOR PRODUCED NON-EXISTENCE EMERGING FROM CRITIQUE 3	
• Geologically-reductionist Anthropocentric narrations of risk • Scientists as arbitrators of human-environment relationships • Dualistic explanations of social-ecological risks • Representation of humans as a homogenous modernist grouping • Positioning of humans outside of the web-of-life • Consequentialist framings of social-ecological risks, with an ecological bias	• Representation of industrial development and technological innovations was as a progressive march forward • Linear narration of consequences, which are technologically rooted and techno-scientifically resolvable. • Articulation of risk outside of relations • Globalising perspectives of risk • Conflation between evidence of impacts with causes of impacts

What has also become visible are the host of activist-researchers, and citizen-researchers, and citizens-who-are-sometimes-researchers, epistemic warriors or recuperators, who are working to generate a host of onto-epistemic imaginaries which might serve us better in generating futures that are more survivable and liveable, for more of us (human and other-than-human kindred).

Each of these critiques provides insight into why the ecologies of knowledges evidenced within the field of practice of citizen science have been rendered nonexistent, or delegitimated within mainstream scientific reporting. Each enables me to make visible that such nonexistence is produced, rather than naturally arising. The critiques also enable a way to reclaim epistemic legitimacy for those forms of knowledge and knowledge production which fall beyond the

legitimizing criteria of abyssal modes of reasoning and producing scientific knowledges - or if not legitimacy, then at least potential legitimacy. In Appendix 11, I consider this more carefully through a discussion on increasing rigour.

3.6. Developing Pluralistic Onto-epistemic Imaginaries

I come back to the quote with which I started this chapter: Santos (2004:14-15) argues that,

what does not exist is in fact actively produced as nonexistent, that is, as a noncredible alternative to what exists. Its empirical object is deemed impossible in the light of conventional social science, and for this reason its formulation already represents a break with it. The objective of the sociology of absences is to transform impossible into possible objects, absent into present objects.

To paraphrase, Visvanathan (2006), what is called for is the creation of embedded alternatives, where knowledges are in dialogue with each other, within a pluralist world of cognitive possibilities where emergence rather than reductionism is emphasised. If one particular mode of scientific knowledge production is inadequate as the only legitimate and appropriate form of knowledge-making within contemporary contexts of risk, then there is a need to revisit how to better use scientific knowledge within ecologies of knowledges, and how to expand systems of epistemic legitimation. In each of the critiques, I have pointed to emergent onto-epistemic imaginaries to re-orient how it is possible to conceptualise foci for knowledge building, and how one might better go about co-producing knowledges. Each of these openings re-orient the knowledge-building process as commoning, towards resolving social-ecological risk and building the common good. They shift epistemic activity away from established trajectories of knowledge production - trajectories which are normatively oriented towards reproducing hegemonic scientific rationality - and instead re-arrange how one may work with knowledge so that more the dominant forms of science is one of the knowledges we are working with, rather than the only orienting mechanism for knowledge production and translation into the lived worlds of citizens.

In the first critique - knowledge production within the sciences - onto-epistemic imaginaries are geared towards reconciling the nature-society divide, and recognising the already pluralistic nature of scientific knowledge production. Said another way, the historically dominant ontological framework of modernist scientific knowledge production is challenged and re-oriented. This firstly, works to reconcile the two universes and related processes of knowledge

production which have underpinned much of scientific knowledge production which led to the social-ecological crisis, and secondly, dismantles the bases of exclusion and expulsion of other forms of knowledge which are currently delegitimated on the basis of dualistic rationality. The intention is a re-orientation of modernist scientific rationality which both strengthens scientific knowledge production itself, and enables it to more authentically engage with other ontologies and their epistemologies.

In the second critique - science and its publics - onto-epistemic imaginaries are leveraged in order to re-imagine knowledge production whose central concern is safe-guarding the common good. Here knowledge flow is troubled and again, re-oriented towards a pluriversal approach to radical democracy, where knowledge conceptualisation and production situate science as one form of robust knowledge amongst many, and the intention is to move beyond consensus and towards working with the complexity of diversity. Focus is shifted from developing scientific literacy to enable compliance and commercialisation towards scientific literacy as a tool for enabling inter-cultural translation (Santos, 2004) and as a tool for supporting the ongoing process of building and enacting knowledge related to 'matters of concern' (Latour, 2004). There is recognition of the diverse and plural nature of publics, and an invitation to broaden this conception to include past, future and non-citizen humans, as well as the other-than-human world.

The third critique - the construction of environmental risk within the Anthropocene - provides onto-epistemic imaginaries which are geared towards strengthening relationality, and reorienting relations between humans and within the web-of-life more broadly. Here, scientific forms of evidencing risk are re-situated within a framework which does not reduce riskiness to such evidence, nor use such evidence to constitute further epistemic activity. Risk-responsiveness is allowed to go beyond geo-chemico-biological stabilisation, towards reconstitution, re-imagination, and reclamation. Humans are reclaimed within the web-of-life, and once again, ecologies of knowledges are enabled as more robust responses to social-ecological risk.

It matters how commoning commons commons.

It matters how knowers acknowledge knowers,

It matters how knowledges enable the knowing of knowledges.

CHAPTER 4

The Methodological Tango

There is space between us, an interval, a gap, and I am not worried about closing it, filling it, crossing over it, because the movement that sustains us in this dance needs to remain relational. And in order to be relational it needs to embrace difference and difference is always there ... But something moves in the space between ...

(Gritzner, 2017:58).

4.1. Introduction

In the first half of this chapter, I outline the research processes undertaken in the generation and analysis of data in this study. I outline the process in three search cycles, describing sampling, data generation methods and analytical processes. In the second half of the chapter, I work more deeply with what it means to engage in research from a post-abysal stance, as well as to think and enact research as 'commoning'.

I intend to describe how I resisted the hegemonic systems which produce knowledge by 'distorting data into clarity' (Law, 2004), and instead engaged in ever-deepening levels of reading data-through-theory-and-theory-through-data to account for 'previously unthought data' (Jackson & Mezzai, 2013). Childers (2014) talks about processes of promiscuous analysis, which resist limiting data analysis to coding practices, and rather engage multiple approaches to analysis - this aptly describes the approach (unintended as it was) to data generation and analysis adopted in the study. Childers describes promiscuous analysis as being always aware of "how the physicality and affectivity of our experiences with the empirical are always already promiscuously entangled with theory" in response to challenges we are seeking to resolve (2014:819).

I offer an account of methodology which is analytically and politically responsive, inquisitive and accountable, and which responds to the vibrancy and politically entangled world in which it hopes to intervene in good ways. As with Childers (2014), I hope to provoke and defiantly open up spaces and openings for different living. Like Childers, I have tried to be faithful to deliberate, rather than indiscriminate, promiscuity in my research approach. As you might have noticed, the thesis thus far, has been peppered with layers of questions which subtly and overtly stretch, open and reclaim ground - an approach which is continued in this chapter. Latour (2004) warns of linear, clean narrations of scientific knowledge production. What is described here is a retrospective (re)presentation of the contours of what was most definitely a nonlinear, messy, entangled research journey that remained uncertain, emergent and generative. The study was situated in a living community of practice, and I myself, was involved in a number of projects, processes and practices which constantly intruded on my meaning-making and analysis processes. The rise to prominence of the #FeesMustFall movement, and call to decolonisation forced me to engage with and recognise the inefficacy, and systemic violences of hegemonic forms of knowledge production and propelled me to engage with more politically conscious and rigorous methodological decisions.

4.2. Research Process

The study unfolded in three cycles of research:

First Cycle: A pilot study (see 4.2.1.) and initial literature review (Chapter 1) - Cycle 1 provided the basis for the initial study design, which was concerned with strengthening justice through supporting epistemic access to the sciences within citizen science projects.

Second Cycle: This cycle began with a mapping of the field of citizen science practice in South Africa (4.2.2., presented in Chapter 6). Cycles 2 and 3 were messy and blurred into each other as I worked and then reworked various sections of the study.

Third Cycle: The final cycle of the study (see 4.2.4) involved a post-abyssal engagement with all aspects of the study, especially the field of literature (Chapter 5) and an imminent critique of the general cultures of knowledge production in response to risk (Chapter 3), as well as informing the analysis of three illustrative case studies (Chapter 7).

Following Latour's (2004) appeal about the importance of making research processes visible, Figure 16 provides an overview of my messy research process, as compared to the ordered linear narration represented through the written thesis format.

4.2.1. First Cycle: Pilot Study and Initial Literature Review

I began the study through an initial (but substantial) literature review of peer-reviewed journal articles reporting the implementation of citizen science projects. My literature search was focused on the key words 'citizen science', and specifically included those papers describing the implementation of citizen science projects, rather than those focused on reporting data and findings arising out of such projects. Key insights arising out of this review process are summarised in 1.2.

During the proposal development stage of the study, before formal fieldwork began, I conducted a small pilot study. The pilot was intended to inform the development of the research proposal and research questions. While I had an initial idea of a research focus based on an even earlier literature review, I felt that a small pilot study would both help me to refine specific research questions, and allow me to test out some initial analytical ideas. The aim was to gain preliminary insight into localised practices. Key for me was the design of contextually relevant and appropriate research questions that would inform my practice as an educator.

UNFOLDING OF THE THESIS PROCESS COMPARED TO STRUCTURE OF THESIS REPORT

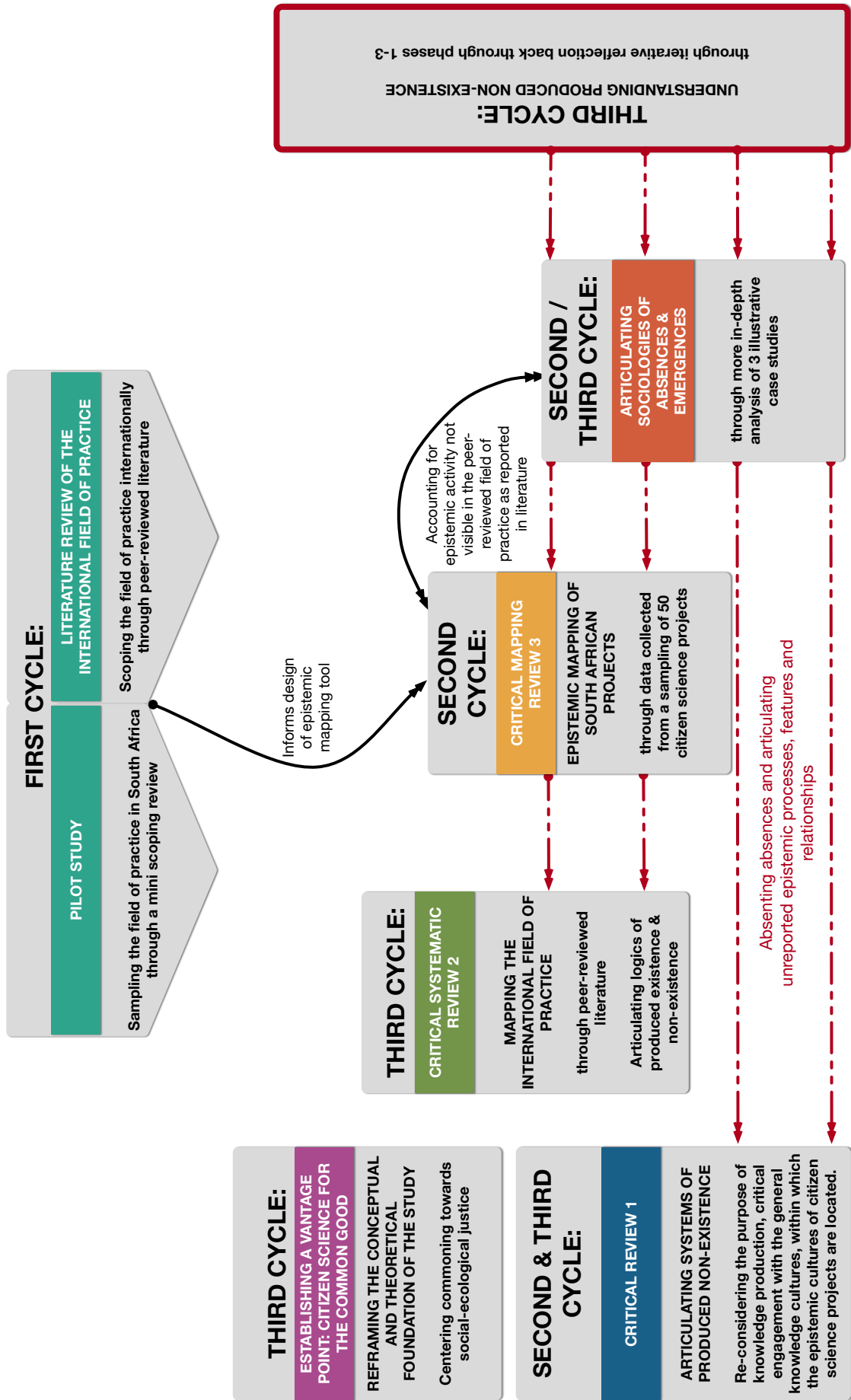


Figure 16: Unfolding of the thesis process

To begin with, my interest was centred on citizen science as an innovative pedagogy (Sharples *et al.*⁷⁹, 2014; JISC CETIS, 2011; Johnson *et al.*, 2011) that had the potential to inform and strengthen science knowledge and skills development within the biodiversity sector in South Africa. The initial literature review unearthed a tendency to *imply* learning in citizen science projects, without substantive research into what precisely this meant (see 1.2.6).

The pilot study involved an initial scoping review of three South African citizen science projects:

- iSpot Southern Africa - a large multi-project citizen science portal catering specifically to species monitoring through data forms and photos;
- miniSASS - a river health monitoring toolkit; and
- Mathuba Schools and Citizens River Health Programme - a school-based, and multi-process project.

The projects covered different spacial and temporal scales, and varied in terms of the online tools, platforms and forms of engagement offered to citizen scientists participating in these projects. I reviewed the online resources of the three projects to get a general 'feel' for the scope of activities, approach to citizen science, and self-descriptions of the projects.

I then did a basic level of Critical Discourse Analysis (CDA) to gain an understanding of some of the epistemic features of each project. Fairclough and Wodak describe critical discourse analysis as an approach to analyse the "partially linguistic character of social and cultural processes and structures"(1997:271, also see Fairclough, Jessop & Sayer, 2002). For the pilot, I used O'Regan's TACO Model (treating the Text As a Critical Object) to analyse the self-descriptive text on the project websites (2011, 2006). My aim was to use critical discourse analysis to assist me in analysing actual instances of social interaction and ideology in linguistic form (O'Regan, 2011, 2006). Analysis was limited to those pages describing what projects were about (rather than methods, participation tools, and project reports). A copy of the Pilot Analytical Tool can be found in Appendix 3.

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4.2.1.1. Initial findings of the pilot study

The initial CDA analysis of the three projects in the pilot study highlighted the following (each aspect is explored in more detail in Chapters 6 and 7):

- There were three significantly different approaches to citizen science evidenced across the pilot cases, with substantial differences in practice, and potentially different epistemic cultures;
- Notions of citizenship and ‘citizen scientist’ were fluid, and took on specific meanings within the context of different projects. However, there was some ambivalence between traditional scientist-fieldworker relationships and new forms of increasingly collaborative relationships emerging. Roles appeared to shift and change, and included some fluidity between roles which are maintained as distinct within more traditional scientist-field worker relationships;
- None of the projects seemed to have clearly and purposefully integrated epistemic relationships between scientific investigation, citizen involvement, learning and science skills development. Nor was there a clear articulation of who owned data being generated or collaborative knowledge being produced;
- While there were some similarities between internationally reported citizen science projects, and those within the pilot study, there were also significant differences which required further investigation. This is evidenced in more detail between the literature review of citizen science practice (1.2. and Chapter 5), and analysis of the field of practice (Chapters 6 and 7);
- Learning was constructed and seen in very specific ways, and mediated through the affordances of various epistemic objects; and finally,
- Online epistemic objects in the form of mediation tools and platforms played a significant role in shaping and mediating epistemic activity in terms of who participates, how they are able to, and do participate, and what sorts of relationships, forms of participation, and learning encounters are enabled or disabled.

Table 1: Implications of findings from pilot study for research questions and study design

Emergent findings	Links to research questions & study design
Different approaches in practice meant possible differences in epistemic cultures	This meant that my research sample needed to include a range of projects across different project approaches, and which responded to various knowledge imperatives and social goals, in order to truly articulate a landscape of citizen science practice.

Emergent findings	Links to research questions & study design
Citizens and scientists as epistemic subjects in epistemic relationships with each other	Sub-question: What are the relationships between epistemic subjects in different approaches to citizen science?
Epistemic objects are especially significant in the study as epistemic mediators	Sub-question: What roles do epistemic objects play in mediating participation in citizen science projects?
Science knowledge and skills development, and educational orientations are under-researched	Sub-question: How is learning shaped by epistemic cultures, subjects, and objects in different approaches to citizen science?

The pilot directly informed the second cycle study design and research questions (which underwent a substantial review in the third cycle). An initial reading of international literature in the field had led me to believe that the majority of citizen science projects focused on species-mapping, leading to a bias in my assumptions about the field. The pilot indicated that this might not be the case in South Africa, and also that I did not yet have enough evidence to coherently discuss other approaches to citizen science.

4.2.1.2. Initial research questions emerging from the first cycle

The following research questions were refined through the pilot study, and informed the second cycle of research:

Main Question: In which ways do citizen science projects facilitate or impede epistemological access to foundational science knowledge and skills?

Sub-questions:

1. What is the context of citizen science in South Africa?
2. What are the relationships between different epistemic subjects in selected citizen science projects?
3. What roles do epistemic objects and non-agents play in mediating participation in selected citizen science projects?
4. How is learning shaped by the different epistemic cultures in selected citizen science projects?

4.2.2. Second Cycle: Epistemic Mapping of the Field of Practice in South Africa

The term 'social mapping' is often used to describe the visual, and geographically bounded mapping of social structures and practices within a particular context, while 'cultural mapping' denotes mapping of identity and assets within a particular culture. Drawing on these backgrounds, I developed a process for mapping epistemic cultures: *epistemic mapping* focuses on making visible the epistemic features of particular social-cultural activity systems. My notions of epistemic features were based on an expansion of Cetina's work on epistemic cultures (2009, 2007; also see 2.3). In keeping with the argument outlined in Chapter 2, epistemic features are considered relationally rather than seeking definitive labels and categories. Maps, in this context, resonate with Kitchin, Gleeson and Dodge (2013:2) for whom,

maps are conceived as being always of-the-moment, brought into being through practices (embodied, social, technical, political); that they are always in the process of mapping. As such, maps are never fully formed and their work is never complete. Maps are transitory and fleeting, being relational and context-dependent.

Still in resonance with Kitchin *et al.* (2013), epistemic mapping, for me, is neither ontologically stable, nor objective. Epistemic maps are inscriptions which simultaneously seek to capture and ideologically produce the world (Wood & Fels, 2008; Goody, 2006; Law, 2004; Latour, 1999), and emerge as 'solutions to relational problems' (Kitchin *et al.*, 2013). Through epistemic mapping I seek to make visible epistemic relationships within the contexts in which they arise, with the intention to better understand how these relationships enable or disable response to social-ecological risk. Epistemic mapping is an attempt to hold epistemic relationships stable for a time, so that they might be used to navigate and think about epistemic cultures. Such maps are also inherently unstable and ever-changing because what they seek to map is in fluid, and shifting relation with the epistemic cultures and worlds within which they are situated. Epistemic maps are therefore propositional, rather than fixed accounts of objective reality (Latour, 2004; Kitchin *et al.*, 2013). Epistemic mapping is one way of enacting onto-epistemic imaginaries (Law, 2004). Maps, in such incarnations, are embedded in wider discursive fields and forms of praxis (Kitchin *et al.*, 2013).

The epistemic map, in this research cycle, is a landscape map - through it, I sought to represent the landscape of epistemic cultures enacted by citizen science projects in South Africa. In the representational forms of the maps generated in this study, arrows, dotted boundary lines and systems of expanding activity were used in an attempt to signal movements, shifts and instability.

4.2.2.1. Development of an epistemic mapping tool

The design of the epistemic mapping tool was informed by three key stimuli: a) findings from the mini pilot described above, in which the web pages of three diverse citizen science projects were analysed using critical discourse analysis; b) through an analytical framework drawing on Cetina's framing of epistemic cultures and their features (2009, 2007, also see Chapter 2), and c) through an international literature review on the social aspects of citizen science (also see Chapters 1 and 5). A copy of the mapping tool indicating these three influences is attached in Appendix 4.

Pilot data yielded a more nuanced understanding of some of the complexities within the three projects analysed, informing significant fields for inclusion in the mapping tool. These included:

- complex relationships between epistemic subjects (pointing to the need to collect more detailed data);
- shifting (and sometimes plural) purposes for epistemic activities;
- the significance of epistemic objects and socio-material features in mediating epistemic relationships between epistemic subjects; and
- the layering of multiple forms and levels of activity within projects.

Based on the above, the mapping tool consists of three broad areas:

- a) Demographic questions
- b) Questions focused on the epistemic features of projects (including epistemic subjects, objects and activities, with particular focus on education, training and mediation activities)
- c) A range of questions designed to inform the citizen science community of practice in South Africa as a form of reciprocal feedback⁸⁰ into the field.

4.2.2.2. An (im)modest sample

Based on a lack of peer-reviewed literature on citizen science initiatives in South Africa, my initial impression was that there might be a dozen active citizen science projects at most, a few of which I was already familiar with. My plan was to do a macro-mapping of 100% of the active projects if possible, and then engage in more focused work with four or five in-depth case

⁸⁰ The generation of this data was intended to provide practical and immediately useable service to the practitioners working in the arena of citizen science in South Africa. It was collated into a database of projects. The database has already been used several times by different partners wanting to network with other citizen science projects.

studies. In an attempt to identify projects, I conducted a web search for any and all projects with the key words 'citizen science' and 'South Africa', expanding the search to include all projects in 'Africa'; I also looked for both media articles and project websites. This approach yielded only 12 projects, which I contacted to arrange mapping interviews.

Each time I interviewed a project manager, I would ask if they knew of any other projects, resulting in a slow creep in sample size; each time interviewees might mention just one or two more projects, and it seemed unrigorous to me to exclude these newly identified projects from my intended 100% mapping exercise. The Animal Demographic Unit (ADU), where I intended to interview project managers from five different projects turned out to have closer to 30 projects, many based on a similar model and hosted on the same platform. There was little point in excluding any of the projects from what had historically been the largest and oldest grouping of citizen science projects in the country. Combined, the search process yielded approximately 56 citizen science projects currently active in South Africa - a far greater number than the 12 - 15 initially anticipated. Six of these projects were excluded due to project suspension or my inability to secure an interview.

I successfully set up interviews with 23 projects for face-to-face or Skype interviews. Of the 50 projects, 31 are based at the ADU, with 27 of them administered fully by virtual systems, and only four actively managed by project staff. All projects managed by project staff were included through individual mapping. All of the digitally managed projects are run on the same model of practice; this model is used as the underlying infrastructure for the majority of projects run out of the ADU. A general interview with the unit manager was conducted to inform insights about these projects, supplemented by a review of the online systems of the virtual projects.

When I reached 50 projects, I realised that there was something much larger than my thesis supervisors and I had imagined happening in the citizen science landscape. I stopped mapping projects, and acknowledged that I had already collected a substantive amount of rich data. Due to the large amount of data already generated through the mapping process, including four to five in-depth case studies was no longer feasible, and I needed a new way forward. My plan was to complete the analysis of the mapping data, and then select a more modest number of case studies to engage with.

After the data analysis arising from the mapping process was completed, and in order to contain the scope of analysis, I made the decision to expand and deepen the analysis of mapping data, and to work with three illustrative cases instead of the planned five (see 4.3.2.1. below). The complexity and diversity of epistemic cultures surfaced through the mapping process, clearly indicated that each project had unique and substantively distinct epistemic cultures, and the most that could be said about any similar grouping was that they had shared tendencies and approaches (see Chapter 6 for an explicit presentation of these findings). In the end, 50 projects were included in a macro-mapping of citizen science practices, and three illustrative case studies used to deepen understanding.

Table 2: Projects included in the epistemic mapping process

ANIMAL DEMOGRAPHIC UNIT (ADU) PROJECTS	PROGRAMMES RUN BY OTHER ORGANISATIONS & GROUPS
1. Birds in Reserves (BIRP)	32. Conservation of Rare and Endangered Wildflowers (CREW)
2. Bird Picture Archive	33. EWT Migrating Kestrel Project **
3. Birds with Odd Plumages (BOP)	34. EWT Ground Hornbill Project **
4. Bird Roadcounts (CAR)	35. EWT Roadkill Project
5. BirdPix	36. EWT Sasol Vulture Monitoring Project **
6. Coordinated WaterBird Counts (CWAC)	37. ifoundahedgehog (ifah)
7. EchinoMap	38. Iimbovane Outreach Project
8. FrogMap	39. Isimangaliso Sea Turtle Citizen Science Initiative
9. Hadedda Ibird Project	40. iSpot (Citizen Science Species Mapping Portal)
10. LacewingMap	41. Khulumani Water for Dignity
11. LepiMap*	42. Mathuba Schools and Citizens River Health Programme
12. MammalMap*	43. MiniSASS
13. MushroomMap	44. Oceanographic Research Institutes Cooperative Fish Tagging Project (ORI-CFTP)
14. MyBirdPatch	45. SA Jelly Watch
15. Nest Records (NERCS)	46. SeaKeys Sea Fish Atlas ***
16. OrchidMap	47. SeaKeys Sea Slug Atlas ***
17. OdontaMap	48. SeaKeys Sea Coral Atlas ***
18. Ornithological Observations	49. The Calendar Gardens
19. Penguin Watch	
20. Photos of Weaver Nests (PHOWN)	
21. ReptileMap	
22. Southern African Bird Atlas Project (SABAP)	
23. South African Bird Atlas Project 2 (SABAP2)*	
24. South African Butterfly Conservation Assessment (SABCA)	
25. Southern African Reptile Conservation Assessment (SARCA)	
26. ScorpionMap	
27. SeaBird Atlas	
28. South African Bird Ringing Unit (SAFRING)*	

ANIMAL DEMOGRAPHIC UNIT (ADU) PROJECTS	PROGRAMMES RUN BY OTHER ORGANISATIONS & GROUPS
29. SpiderMap 30. TreeMap 31. Virtual Tree Herbarium (ViTH) <i>*ADU programmes mapped through interviews. An interview was also done with the manager of the ADU to gain insight about historical and fully digital projects.</i>	50. ToadNUTS <i>** Same project manager based at the Endangered Wildlife Trust (EWT) - single interview for three project maps.</i> <i>*** Same project manager within the larger SEAKEYS project - single interview for three project maps.</i>

Involvement in a subsequent project on water quality monitoring highlighted a gap in my sampling technique: many community-initiated and local projects have no online portals, and are often not affiliated with larger organisations like universities or government programmes. They are invisible, except through local networks, and therefore fell out of range of my sampling process. While insights gained through other research processes involving these projects have informed my understanding of the field of practice, no specific data was collected for them during this phase of research. Future research would need to consider how such projects might be identified for inclusion.

4.2.2.3. Epistemic mapping interviews

Project managers and co-ordinators were identified as key informants for each project, and asked to complete the mapping tool. Access was negotiated via host organisations (where available). Project informants were given three options for completion of the mapping tool, depending on accessibility and availability:

- 1) Face-to-face interviews, where I entered data into the mapping protocol through a semi-structured interview process. These interviews yielded rich data, well beyond the scope of the mapping tool, and interviews were recorded for later reference.
- 2) Online Skype interviews, where I entered data into the mapping protocol through a semi-structured interview process. While these interviews tended to be shorter in duration because of their digital nature (generally an hour or less), they also yielded rich data beyond the scope of the mapping tool;
- 3) Self-completed mapping forms - this form of contribution was discouraged because of the limitations of input possible through self-completed forms. Only two informants opted for this form of contribution. No additional data was collected related to these projects.

Interviews were conducted with project managers or programme coordinators, leaving a significant gap of insight which might have emerged from citizen scientists or other categories of project participants.

In addition, I attended and participated in a number of citizen seminars and was invited to observe a range of workshops. These include both project-specific meetings and workshops, as well as one large citizen science symposium with representatives of more than 30 projects present. While I did not engage in any formal data collection processes during these, they provided valuable opportunities for me to both present some of my initial findings for feedback, as well as corroborate insights emerging from formal data collection processes. Being part of a citizen science reading group challenged me to engage with literature more critically, and exposed me to multiple perspectives arising from other doctoral scholars working in overlapping areas.

4.2.3. Unravelling: The Satisfaction of Finding More Than I Imagined

Law (2004) challenges us to consider how research can become distorted into clarity in our attempts to make it representable. He points out that,

If much of the world is vague, diffuse or unspecific, slippery, emotional, ephemeral, elusive or indistinct, changes like a kaleidoscope, or doesn't really have much of a pattern at all, then where does this leave social science? ... If the world is complex and messy, then at least some of the time, we're going to have to give up on simplicities (2004:2).

After the initial analysis of mapping data, three wonderful and unsettling things happened:

- 1) It became evident that the epistemic cultures within diverse citizen science projects were complex, and resisted easy classification or description;
- 2) As I was finalising the epistemic mapping analysis, the *#FeesMustFall* movement, along with focused attention on decolonisation and counter-hegemonic knowledge production began to dominate the academic arena in South Africa and elsewhere. The seminars and readings I encountered during this time significantly challenged my views of knowledge production, especially as it related to social-ecological justice. They compelled me to re-think the purpose and processes of knowledge production. The work of Boaventura De Sousa Santos was particularly alluring and challenging.
- 3) I was invited to contribute a chapter on citizen science to a book entitled *"Envisioning Futures for Environmental and Sustainability Education"* (see Appendix 7). The chapter

allowed me to experiment with Santos's conceptualisation of 'ecologies of knowledges' (2007, 2004). I had read his paper, *'Beyond Abyssal Thinking: From Global Lines to Ecologies of Knowledges'* (2007), and the arguments he presented there haunted me, both because they made visible to me my own 'metropolitan' thinking, and because the concept of 'ecologies of knowledges' seemed to offer so much towards articulating the epistemic cultures of citizen science projects. The book chapter offered a chance to 'test-drive' the theoretical and methodological work Santos argued for. The chapter took shape more naturally than any other piece of work I had written to date; through it, I was able to clearly account for something that had been all but invisible in the literature on citizen science. There was no going back - in order to be authentic, and to honestly report my research findings, I needed to revisit my thesis so that the 'ecologies of knowledges' that were so evident in the book chapter could be coherently evidenced into the thesis.

The complexity of the initial research findings, accompanied by the far more coherent analysis made possible through Santos's work, together, called on me to revisit every aspect of the thesis thus far; research questions, conceptual and theoretical frameworks, analytical tools and research methodology all needed more careful, and critical engagement. Not only did I need to integrate this new layer of theory, I also needed to understand why such ecologies were poorly, or most often unrepresented in the field of literature.

Due to the scope of work requiring review, I needed to find a way to manage the size of this study. This was done by surrendering focused engagement with the role of epistemic objects within the epistemic cultures of citizen science projects. This was a pragmatic decision, rather than one based on any lesser relevance of this aspect of epistemic cultures. It is my hope to return to this area after the thesis is complete.

4.2.4. Third Cycle: Mapping Sociologies of Absences and Emergences

In the third cycle, I began to 'map', and make visible, signals of ways of knowing which were largely absent in the literature, and which I had not intentionally framed into my mapping tool. My interest expanded from what Kitchin et al., (2013) describe as a representational form of mapping which sought to establish even a momentarily stable ontology (what things are) towards a processual or ontogenetic form of mapping (how things become). This led to a

different form of epistemic mapping - one through which I intended to make visible 'ecologies of knowledges' within the field of practice, as well as attempting to understand why epistemology (scientific ways of knowing, from episteme indicating 'certain' knowledge) were being privileged over gnosiology (a broader philosophy of knowledge and more encompassing system of ways of knowing).

4.2.4.1. Revised research questions

The re-working of each aspect of the thesis from a post-abyssal perspective resolved into these research questions. These are the questions I finally respond to in this thesis.

Research Question:

How do the epistemic cultures within citizen science projects enable commoning in response to social-ecological risk?

Sub-Question 1:

What is the epistemic landscape of citizen science within South Africa?

Sub-Question 2:

How are ecologies of knowledges constituted within particular citizen science projects?

Sub-sub question: In which ways do diverse knowledges and types of knowing contribute to knowledge co-production, learning and action within the citizen sciences?

Sub-Question 3:

How are the epistemic cultures of citizen projects articulated within peer-reviewed scientific reporting?

Philosophical Question: (philosophical re-orientation)

How are broader knowledge cultures, within which specific epistemic cultures are located, constituted to privilege or denigrate, legitimate or delegitimate particular types of knowers and knowledges, and towards which ends?

Sub-sub question: How might this enable or disrupt commoning in response to social-ecological risk?

4.2.4.2. A post-abyssal expansion

The third cycle included five simultaneous steps:

- I began by investigating openings and signals of ecologies of knowledges within three illustrative case studies;
- I noticed a discrepancy between what I was reading in research reports about citizen science projects and what I was 'seeing' in the two forms of mapping engaged in the thesis. In order to try to understand why the differences arose, I realised that I needed to gain some understanding of general knowledge cultures and the logics of produced non-existence;
- As I began to gain insight into various logics of produced non-existence, I realised that I needed to re-visit and more rigorously analyse the literature arising from the field of citizen science, this time reading for both presence and absence;
- I realised that the argument for the thesis required substantial re-alignment, and that I needed to establish a vantage point for the thesis which centred my interest in social-ecological justice for the common good;
- I needed a stronger post-abyssal approach to methodology - one which adequately unsettled hegemonic tendencies in the first and second cycles of research and more strongly enacted the justice interest underpinning this study.

4.2.4.3. A post-abyssal mapping of epistemic cultures: three illustrative cases

Developing the original analysis published in the book chapter (Appendix 7), I selected three illustrative case studies to explore in more detail through purposeful-convenience sampling. The case studies were chosen because: a) they provided a diversity of approaches to citizen science in South Africa; and b) I was able to access various forms of reporting on each of the projects, without needing to go back into the field for another in-depth process of data collection. The case studies focused on a diversity of project foci, institutional arrangements and bases of participation. The three projects worked with science in diverse ways, and enacted a similarly diverse array of knowledge interests. I had a more in-depth understanding of each of the three cases selected because of related systems of activity or informal participation in various of their project activities.

I felt that this approach to data sourcing was valid because the intention of this process of epistemic mapping was to search for signals and openings which might be explored further,

rather than intended to produce a definitive way of establishing in-depth enactments of ecologies of knowledges in the projects. At the start of this cycle of research, I was already three years into the study, and having recognised that I would need to rework almost every part of the thesis thus far, I made the pragmatic decision to articulate openings as a starting point for 'thinking citizen science', rather than undertaking the in-depth research that this form of research undoubtably deserves. An initial testing of my analytical approach proved sufficient to illustrate the ecologies of knowledges enacted within each case study, leading to rich data from diverse data sources in each case - more than could be analysed effectively within the space of this thesis.

Tempered by the approach to data collection, the intention of the case studies was not to provide a basis for generalised insights about the field of citizen science practice, but rather to illustrate an expansive post-abyssal account of the epistemic cultures of these specific projects, and how such accounts provided signals and openings for supporting and strengthening citizen science towards social-ecological justice for the common good more deeply. Insights arising through analysis were propositional, rather than fact-making. Each case study is an enactment of onto-epistemic imagination and re-imagination, rather than a set of certain knowledge claims. The relevance to the field of study, then, is at an ideological level which demonstrates the power of 'thinking epistemic cultures' through post-abyssal sociologies. At an individual level, it is my hope that the case studies might practically inform the enactment of each of the specific projects analysed. Detailed descriptions of each case study are presented in Chapter 7, and an articulation of the theory informing the analysis is described in Chapter 2. An outline of the data sources informing each of the case studies is summarised below.

Illustrative Case Study 1: Custodians of Rare and Endangered Wildflowers (CREW):

The CREW case study is evidenced through extracts from the *CREW 2017 Newsletter* (SANBI, 2017), three annual reports (Parbhoo, 2019, 2018, 2017), and the draft *CREW Operations Manual* (CREW, 2019), as well as an interview with Ebrahim (2014), who is a member of the coordinating team. It should be noted, however, that interview data was retrospectively analysed to inform this chapter, rather than being intentionally constructed to elicit data related to ecologies of knowledges. Additionally, while the CREW newsletters (SANBI, 2019, 2017) are by no means a comprehensive report of activities, they do provide an overview of what is

prioritised as legitimate activity, and what is recognised as legitimate knowledge among CREW teams - the newsletters are compiled by both citizen scientists and professional scientists.

Table 3: Data sources for Case Study 1: CREW

Data Source	Interviewee / Author	Source Date
Interview voice recording & notes	Ismail Ebrahim (CREW Cape Floristic Region Node coordinator)	April 2014
Annual Report: Custodians of Rare and Endangered Wildflowers (CREW) Programme: 2016/2017 Annual Report	Suvarna Parbhoo (Programme Manager, CREW)	2017
Annual Report: Custodians of Rare and Endangered Wildflowers (CREW) Programme: CREW 2017/2018 Annual Report	Suvarna Parbhoo (Programme Manager, CREW)	2018
Annual Report: Custodians of Rare and Endangered Wildflowers (CREW) Programme: CREW 2018/2019 Annual Report	Suvarna Parbhoo Mohan (Programme Manager, CREW)	2019
Project protocols Draft CREW Operations Manual	CREW, SANBI	2019
Published report: Monitoring threatened species in South Africa: A review of the South African National Biodiversity Institute's Threatened Species Programme: 2004-2009.	Young, S.	2010
Newsletter: CREW 2017 Newsletter:	SANBI - input from each CREW Node *Data extracts form newsletters are referenced as (CREW, *name of section author*, year of publication) to represent the diversity of authors and node reports.	2017
Newsletter: CREW 2019 Newsletter: April 2019 National CREW overview	SANBI - input from each CREW Node *Data extracts form newsletters are referenced as (CREW, *name of section author*, year of publication) to represent the diversity of authors and node reports.	2019
Programme evaluation report: Review of the Custodians of Rare and Endangered Wildflowers (CREW) Programme: Final Report	Stewart, W.	2019
Published paper: Linking 'citizen scientists' to professionals in ecological research: Examples from Namibia and South Africa	Araya, Schmiedel & von Witt	2009

Illustrative Case Study 2: Khulumani Water for Dignity:

In contrast to the other case studies, at the time the final version of the chapter was written, the *Khulumani Water for Dignity* project had come to an end, which limited my ability to collect additional data; nor was there any grey literature available (as was the case in the other case studies) to provide evidence extracts to illustrate the ecology of knowledges from the perspective of the citizen scientists themselves, beyond the initial mapping data (Chapter 6). However, as an intentional approach to the project, citizen scientists collaborated on various publications and reports which have been analysed, providing some insight into their knowledge perspectives in the project. This was richly documented in a doctoral study encompassing this citizen science project, which also formed the basis of data for this case study, and in project reports and co-authored papers.

Table 4: Data sources for Case Study 2: Khulumani Water for Dignity

Data Source	Interviewee / Author	Source Date
Interview notes for Project Mapping	Mbulelo Lipile (Citizen Science project coordinator)	June 2014
Khulumani Website: https://khulumani.net/active-citizens/khulumanis-water-for-dignity-project-launches-the-grahamstown-east-dignified-schools-project/2015/11/05/ https://khulumani.net/active-citizens/the-khulumani-water-for-dignity-team-and-institute-for-water-research-met-in-vukani-township-grahamstown-on-11-may-2015/2015/05/15/	Khulumani Support Group	2019
Project report: Practicing Adaptive IWRM (Integrated Water Resources Management) in South Africa	Palmer & Munnik	2018
Published paper: Water service delivery challenges in a small South African municipality: Identifying and exploring key elements and relationships in a complex social-ecological system	Weaver, O'Keeffe, Hamer & Palmer	2017
Published paper: Coping with water supply interruptions: can citizen voice in transdisciplinary research make a difference? (*This paper is co-authored by the team of university researchers and civil society researchers)	Hamer, Lipile, Lipile, Molony, Nzwana, O'Keeffe, Shackleton, Weaver & Palmer	2018
Doctoral thesis: Civil society engagement with water governance at a local government scale in South Africa.	Weaver, M.J.T.	2019

Illustrative Case study 3: ToadNUTS

A rich interview that went well beyond the scope of mapping questions provided a key source of data for this case study. As with the CREW case, interview data was retrospectively analysed to inform this chapter, rather than being intentionally constructed to elicit data related to ecologies of knowledges. Interview data was supplemented by a range of publications from diverse organisational perspectives and groups of citizens participating in the project. In addition, two masters studies had been conducted in the previous five years (one of which I co-supervised), both with an interest in learning and knowledge production; these were used as another layer of data informing the case study.

Table 5: Data sources for Case Study 3: ToadNUTS

Data Source	Interviewee / Author	Source Date
Interview voice recording & notes	Alison Faraday (Civic researcher and project coordinator)	June 2014
Published Strategy Report: Ensuring a future for South Africa's frogs: a strategy for conservation research.	Measey, G.J (ed).	2011
Published article: Conservation of the Western Leopard Toad by a dedicated multi-stakeholder group in the City of Cape Town.	Measey, G., Dorse, S. & Faraday, A.	2012
Published article: Citizen science and the Western Leopard Toad	Farham, B. (editor)	2013
Published report: Monitoring threatened species in South Africa: A review of the South African National Biodiversity Institute's Threatened Species Programme: 2004-2009.	Young, S.	2010
Project website: www.leopardtoad.co.za	Western Leopard Toad Conservation Committee (WLT-CC)	No Date (Sourced October 2019)
Community website: https://www.thenoordhoekhub.com/groups/toadnuts/	ToadNUTS	2019
Masters dissertation: Environmental Citizenship in Citizen Science: A Case Study of a Volunteer Toad Conservation Group in Noordhoek, South Africa. <i>*data source codes have been omitted in quoted extracts)</i>	Van Wyk, S.	2015
Masters dissertation: An Investigation of the Influence of Knowledge-Production and Learning Processes on Complex Practices in a Community-Driven Citizen Science Initiative: A Nature Conservation Case Study	Alexander, J. <i>*study co-supervised by myself)</i>	2020

4.2.4.4. A critical review of the logics of produced nonexistence

Articulation of produced non-existences has emerged throughout the thesis in multiple ways. Chapter 3 provides a focused engagement with three expressions of produced non-existence within three contexts of knowledge work pertinent to the field of citizen science and social-ecological justice. These three focus areas emerged through a literature review of knowledge production in response to social-ecological risk. Each philosophical critique challenges what have come to be naturalised ways of producing and working with knowledge, by engaging post-abysal critiques which foreground various forms of social-ecological justice towards common goods. The aim of the chapter is to firstly provide insight into the operationalisation of hegemonic knowledge cultures and the ways in which they produce particular forms of non-existence, and secondly to re-orient thinking about those broader knowledge cultures within which specific epistemic cultures are located. Invitations into post-abysal ways of re-thinking are provided through the ongoing articulation of onto-epistemic imaginaries throughout each critique.

The critiques included are by no means exhaustive nor comprehensive; instead, they provide openings through which we might begin to challenge the naturalised structural powers of hegemonic systems of knowledge production, and potentially reach towards more robust and responsive ways of knowledge-building towards common goods.

The critiques include:

- *Critique 1:* Knowledge production within modernist western sciences: A critique of ontological dissonance;
- *Critique 2:* Science and its publics: A critique of knowledge flow; and
- *Critique 3:* The construction of environmental risk within the Anthropocene: A critique of the capitalist narration of risk.

4.2.4.5. A critical systematic review of literature: reading for presence and absence

Where in Chapter 3, I engaged a philosophical critique (albeit based on various trajectories and histories of empirical research), in Chapter 5, I sought to look at a field of practice through the perspectives emerging from the philosophical review. Chapter 5 takes the form of a critical literature review in which I present both presences and absences. The critical literature review focuses on literature specifically describing the epistemic processes and relationships of citizen

science projects, rather than literature reporting data arising from projects. An extensive literature review was conducted across a range of journals using the key phrase 'citizen science'. Of the papers identified, those directly reporting data were discarded. Those describing project implementation were selected, even where there was some discussion of emerging data. A brief review of the abstract of each paper, and a scan of sub-headings and conclusion were used to gain an overview of contents and focus, informing selection. Of the 263 articles identified over the period of the study, 65 were selected for detailed analysis, with the remaining 198 used as 'soft' references providing a wider perspective. Chapter 5 should be read together with the literature summarised in 1.2. The analytical framework summarised in Appendix 5, informed by the theoretical framework described in Chapter 2, was used to systematically review papers for presence and absence. Appendix 10 contains a list of papers reviewed.

4.2.5. Summary of Analytical Chapters

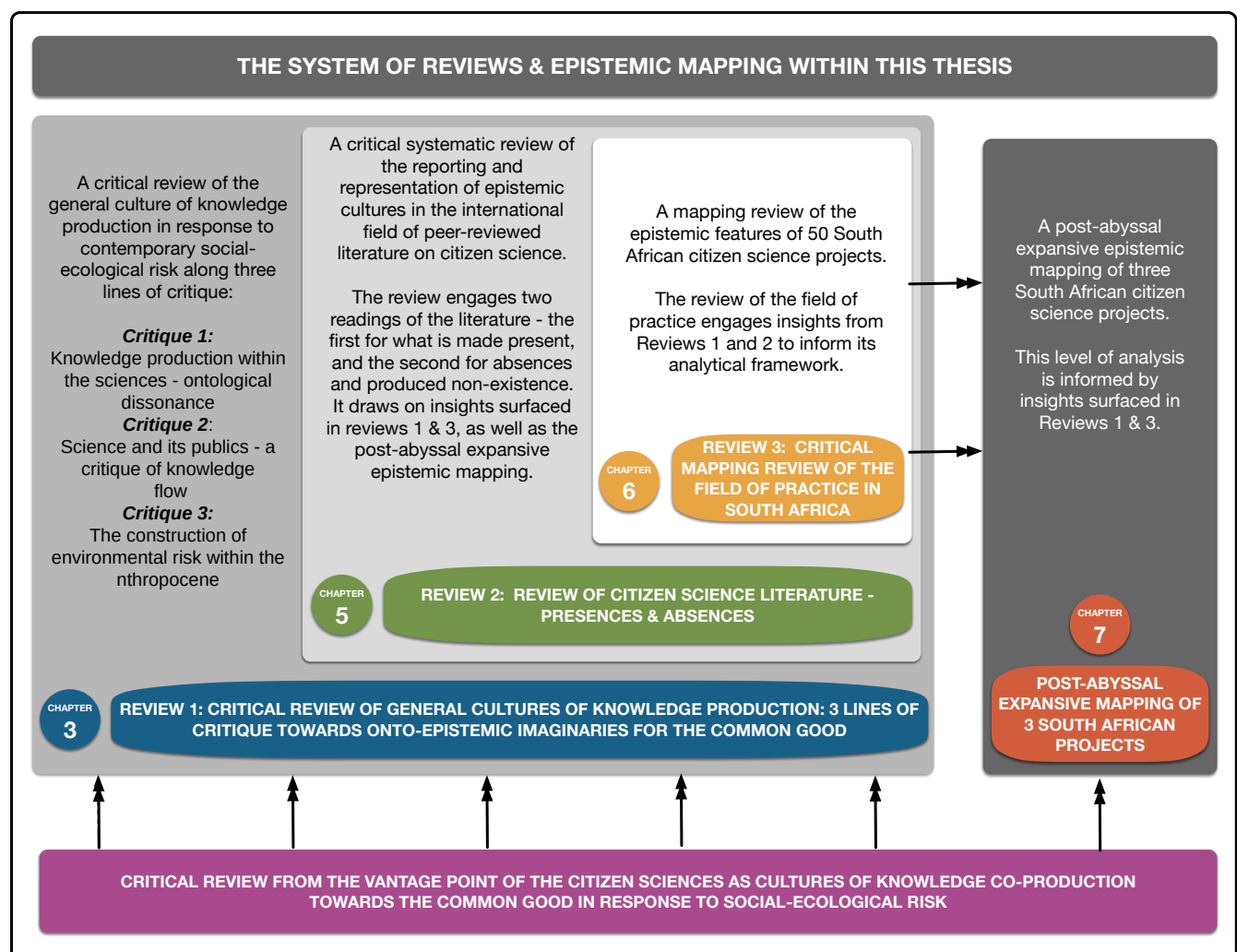


Figure 17: Summary of data chapters within the thesis.

To summarise, this thesis includes four levels of iterative analysis. Chapter 3 presents a critical review of three enactments of produced non-existence within the general knowledge cultures within which citizen science projects are located. Chapter 5 provides a critical literature review of peer-reviewed literature emerging from the field of citizen science, reading for both presence and absence. Chapter 6 provides a mapping review of the field of practice in South Africa, which describes the landscape of epistemic cultures of citizen science. Finally, Chapter 7 offers a post-abysal mapping of the epistemic cultures of three illustrative case studies from the field of practice.

4.3. Deepening Methodological Engagement

... simple clear descriptions don't work if what they are describing is not itself very coherent ... If the world is complex and messy, then at least some of the time we're going to have to give up on simplicities. But one thing is sure: If we want to think about the messes of reality at all then we're going to have to teach ourselves to think, to practice, to relate, and to know in new ways (Law, 2004:2).

This study was initially designed to investigate how citizen science projects might deepen justice by strengthening epistemic access to scientific knowledge production. From this perspective, the methodological design involved a relatively straight forward adoption of established research practice in the social sciences. However, the study was later reimagined in response to: a) findings emerging from the first layer of data analysis; and b) a growing call for decolonial, politically-accountable research within the South African (and global) context. The post-abysal interests that emerged required a form of onto-political rigour that informed and shaped subsequent methodological decisions and called for a re-thinking of the initial research design. An ongoing challenge in writing up a methodological description for the study has been the need to resist methodological simplicity (in the way that Law, 2004 describes), while also providing a rigorous account of methodology which avoids descending into a relativist or anecdotal account.

In the end, I chose to write the methodological description in the following way:

- a) I actively resist drawing on established methods textbooks as legitimating references for the methodological approach adopted. Instead, I chose to make visible (or transparent), how I enact robust research processes which contribute to establishing and strengthening analytical rigour in this study.

- b) Careful attention is given to what Mol (1999) describes as the ontological politics of the study, which calls for articulation of political rigour - I have worked to make the political rigour of the thesis transparent in ways which elevate and make it equally visible to the analytical rigour;
- c) I draw on the metaphor of Argentine Tango to articulate the interaction between hegemonic and expansively post-abyssal methodologies emerging between the initial and subsequent research design decisions.

4.4. Centring Ontological Politics: A Methodological Vantage Point

[B]ehind the assumption that we need such rules and procedures lies a further range of assumptions that are also naturalised and more or less hidden. These have to do with what is most important in the world, the kinds of facts we need to gather, and the appropriate techniques for gathering and theorising data (Law, 2004:5).

At the heart of this chapter is the question:

What does a methodological design which centres the common good look like, in this research?

Law suggests, “[I]t is about how to make good differences in circumstances where reality is both unknowable and generative” (2004:7). Within the broader methodological question are many others, including: *What (if anything) needs to be (re)stor(y)ied methodologically? Is there potential for methodology as ‘commoning’? What needs to be (re)thought, challenged, strengthened, or (re)enacted to enable ‘commoning’, ‘commons’ and ‘goodness’, for whom, and with what intentions?* These questions provided openings through which to make methodological choices as the study unfolded.

Mol opens up this space for us by pointing out that knowledge objects (for example polluted water, or risk of toad extinctions) are always ontologically multiple, always performed, and that once we “start to look carefully at the variety of the objects performed in a practice, we come across complex interferences between those objects” (1999:82). This implies that objects are enacted through multiple realities and that they cannot simply be viewed as different aspects of a single knowledge object, but rather, are different versions of it; these versions might clash at some points, collaborate at others, and depend on one another at yet others or even include each other in some ways, (Mol, 1999; Santos, see 2.9) provides more in-depth arguments substantiating this claim). An ontological politics is enacted in the relationships between the different ontological versions of a single knowledge object. From this vantage point, stories

professionals might offer about knowledge objects are no longer self-evident - they maintain their representative nature, they become overtly contestable, and are recognised as creating particular versions of reality that have effects and relationships with other versions of reality (Mol, 1999). The outcome of relations between multiple ontologies of knowledge objects, and also the interferences between them, is that various political tensions arise, and that knowledge objects are always implicated in unquantifiable numbers of other issues and realities - a knowledge object is therefore never pristine or separate from its relations to neither other versions of the same knowledge object, nor other knowledge objects related to it (Mol, 1999). This builds on Latour's arguments substantiating the need to maintain the visibility of knowers of knowledge, and processes of knowledge-building (2004; see 2.7), and Santos's argument for ecologies of knowledges (see 2.9).

If we are to adopt the perspective that ontology (the nature of reality) is multiple, Mol (1999) argues, then we need to consider more deeply how to go about navigating between the various versions of reality that arise - we need to find ways of navigating between reality-options. Mol's interest is about the ways in which 'the real' are implicated in the 'political', and vice versa (Mol, 1999). Mol challenges us to ask,

... *where* such options might be situated and *what* was at stake when a decision between alternative performances was made. We would also need to ask to what extent are there options between different versions of reality if these are not exclusive, but, if they clash in some places, depend on each other elsewhere. The notion of choice also presupposes an actor who actively chooses, while potential actors may be inextricably linked up with how they are *enacted* (Mol, 1999:74, emphasis in original).

Mol's argument presupposes a view of reality (or more accurately, *realities*) as historically, culturally and materially located. She emphasises the use of the word ontologies, and points out that, "[n]ow the word needs to go in the plural. For, and this is a crucial move, if reality is done, if it is historically, culturally and materially located, then it is also multiple. Realities have become multiple" (Mol, 1999:75).

Mol speaks chiefly to theories which foreground practices as ontology-making. However, her concept of ontological politics also provides leverage for thinking through what decolonial (and other) theorists such as Santos (2007, 2004) and Mignolo (2013, 2011) name as pluriversal, which similarly privilege practice, but also encompass a more extensive referent - but this requires some ground-clearing before we can make this connection fully. Mol resists the notion of plural, preferring instead, the use of multiple (a preference also of Law, 2004). For Mol, reference to

plural is derived from its use in perspectivalism and constructivism. Perspectivism refers to standpoint perspectives which push back against notions of objectivity, where reality is a specific social object for each person - while there are a plurality of perspectives on reality, *reality remains singular* (Mol, 1999). Constructivism, for Mol, is about the construction or stories of how a specific version of the truth was constructed, and how any alternatives were discredited; this stance suggests that alternative reality-constructs *might have been possible, but never blossomed into presence*. Here plurality is projected back, into the past, and once again, reality remains singular (Mol, 1999). Mol uses the term 'multiple' to signal her shift away from these conceptions of plurality which maintain a singular account of reality; the notion of *multiple* on the other hand, is underpinned by the metaphors of intervention and performance, which suggest that it is done and enacted rather than observed. Any object, in such a conception of reality, shifts and varies from activity to activity, practice to practice; definitions, compositions, values, and significances shift depending on who is working with it, and towards which ends. Nor, Mol notes,

... is it the role of tools to lay them bare as if they were so many aspects of a single reality, instead of attributes or aspects, they are different versions of the object, versions that the tools help to enact. They are different and yet related objects. They are multiple forms of reality. Itself (Mol, 1999:77).

These versions ... performances ... realities ... co-exist in the present, and lead Mol to four questions about the kinds of politics that might be used to navigate ontological multiplicity; she asks:

- *Where are the options?*
- *What is at stake?*
- *Are there really options?*
- *How should we choose?* (Mol, 1999:79).

This still leaves us with the apparent disjunction between Mol's understanding of pluriversalism and the pluriversalism proposed by decolonial thinkers, which stretch Mol's notion of multiple even further. Mignolo (2013) for example, uses the idea to stretch into relational work between two or more cosmologies and their pluriverses of meaning. It is a counter-hegemonic conception leveraged against the imperialist universalising project of the West. For Mignolo, pluriversality is not cultural relativism (a world of independent units), but rather the entanglement of countless cosmologies; even though there are stark power differentials

between these cosmologies (2013, 2011). For Santos, post-abyssal pluriversal thinking “is premised upon the idea of the epistemological diversity of the world, the recognition of the existence of a plurality of knowledges beyond scientific knowledge. This implies renouncing any general epistemology” (Santos, 2007:12). Querejazu (2016:3) points out that this goes beyond simply tolerating difference, to a view of reality as “constituted not only by many worlds, but by many kinds of worlds, many ontologies, many ways of being in the world, many ways of knowing reality, and experimenting those many worlds”, where coexistence, rather than relativism, is recognised. For Querejazu and other decolonial thinkers, what is at stake is “an ontological fundament with epistemological and methodological consequences” (Querejazu, 2016:3). Querejazu, too, critiques the limits of theoretical pluralism, charging us to reach beyond any simple notion of tolerance such a perspective might support within a singular world rule. Instead, he argues, we need to reflect on how “these different worlds can coexist not submitted in one reality, but in incommensurability”, even while they might be partially interconnected (2016:3).

Here we see the over-lapping interest between Mol (and other science and technology studies scholars like Law, 2004), and decolonial theorists - a shared interest in plural or multiple realities themselves. Because the two terms - plural and multiple - are so distinct for Mol (1999) with plural holding the weaker meaning, a choice must be made for coherence in this thesis. From my reading, decolonial theorists, and Latour (as significant to this thesis) argue pluriversality in ways that correspond to and are commensurate with the way Mol argues multiversity; in the context of this study, I select the term *pluriversality* over multiversity in light of the post-abyssal interest and alignment with Santos (2004) and Latour (2004), as the two key thinkers influencing the theoretical framework for this study. Pragmatically, the choice is made because in the context of this study, there is good alignment with Mol’s notion of multiple, and because I draw heavily on decolonial arguments to shape the epistemic choices in the thesis. To be clear, I am using the notion of pluriversal to signal multiple cosmologies and for Mol’s argument of reality-making through intervention and performance. While these two traditions are not fully aligned, they are compatible as practice and knowledge investigators within the context of this study.

To hold this space of questioning, Mol offers the composite term of ‘ontological politics’; it brings into relation ontology - “what belongs to the real, the conditions of possibility we live with”, and politics (or systems of empowerment and disempowerment) (Mol, 1999:75). To bring

the terms ontology and politics into relation, then, is to imply that the conditions of possibility *are not given* (Mol, 1999). To speak of politics as it relates to the ontological, is to highlight an active mode of reality-shaping, and also that the character of the processes and practices of reality-shaping are both open and contested (Mol, 1999).

4.5. Engaging Onto-Epistemic Imaginaries

One of the concepts I leverage repeatedly across the thesis is that of onto-epistemic imaginaries as a post-abyssal expansion of systems of knowledge hegemony. The conceptualisation of onto-epistemic imaginaries is primarily derived from the work of Helen Verran (1998), and John Law's engagement with her work (2004). In this instance, Verran's work concerned re-imagining land ownership in Australia, across two ontological systems and their epistemic enactments. Her work took the recognition of ontological politics into the epistemic practices, relationships, artefacts, and social-ecological systems, which are inscribed with such ontologies and make them manifest into our enacted relations. Through an analysis of two distinct ontologies and how they were enacted within systems of land association between pastoralists ceded land through British title, and the Aboriginal people in Australia, Verran illustrated the significance of ontic/epistemic imaginaries (Verran, 1998).

For Verran, 'the imaginary' is fundamental to knowledge work. Her argument is was intended to show, "the imaginary as something constitutive of, and constituted by, ontic and epistemic commitments" (Verran, 1998:238). Here, ontic commitments denote the forms of meaningfulness, and epistemic commitments hold the explanations of their origins (*ibid*). The ontic and epistemic commitments within diverse knowledges are often different, if sometimes somewhat overlapping, as argued by both Mol (1999) and Verran (1998).

Verran brings our gaze into the material/symbolic, recognising the "politics waged over ontic/epistemic commitments; a politics over what there is and who/what can know it" (*ibid*, 1998:238). She argues that we cannot understand ontological politics without paying attention to ontic/epistemic imaginaries (*ibid*). First, she points out that modernity circumscribes its imaginary in terms of the aesthetic, but not ontic or epistemic interests (which are domains of rationality and fact-based knowledges), and that this does not reflect the role of imaginary within Aboriginal communities. However, Verren challenges this position, arguing that to suggest that

western imaginaries do not have a role in constituting ontic and epistemic commitments is a denial dependent on privilege. It is useful only when the sciences hold the unmarked position of privilege with respect to all other knowledges (1998:243). She argues that imaginaries are not located in minds; instead they are located in the practices which constitute our knowledges, laws, and social-ecological relations (*ibid*). She notes that,

imaginaries are enacted and enact. The imaginaries imminent in practices interpellate those objects/subjects that/who are implicated in and by the practices, helping to constitute them as objects/subjects, (1998:252).

If we wish to work between knowledges, then imaginaries need to be brought back into view within and across knowledge systems (*ibid*). To paraphrase Verran, before different groups, engaging diverse epistemologies can generate common knowledge, before they can begin commoning together, they first need to commit themselves to an imaginary which is at least partially shared, through which their commons and common goods are meaningful, and by which their primary categories of that meaningfulness are given.

I shift Verran's terminology slightly, from ontic-epistemic imaginaries, to *onto*-epistemic imaginaries, primarily because Verran's argument seems to bring particular focus on how ontologies are representationally inscribed; my shift to *onto*-epistemic is simply intended to lift beyond the level of inscription towards a level of generativity which encompasses both inscription and those engagements with ontology which might fall beyond inscription or pre-date it within epistemic practice. I am not at all sure that the distinction is required, but am not fully confident that Verran's notion of ontic-epistemic imaginaries can be leveraged in the ways I intend in this thesis. Drawing on Verran, then, recognising and re-establishing *onto*-epistemic imaginaries are about making visible the role of imaginaries in both thinking with existing knowledges and making new knowledges, and also engaging knowledges in new ways. It is about engaging a generative capacity to recognise that all established ontological perspectives were themselves imagined into being based on particular, culturally specific ways of enacting the world, as well as enabling the (re)imagination of how things might be different, or elevated, or enhanced, or re-thought to better serve in the generation of common goods.

4.6. Enacting Ontological Politics: A Methodological Tango

Method, in the reincarnation that I am proposing, will often be slow and uncertain. A risky and troubling process, it will take time and effort to make realities and hold them steady for a moment against a background of flux and indeterminacy [...] It takes longer to do things. It takes longer to

understand, to make sense of things [...] It erodes the idea that by taking in the distance at a single glance we can get an overview of a single reality (Law, 2004:10).

The task in this chapter is to outline the methodology used to conduct this research in order to support its legitimacy as a valid contribution to scientific knowledge. At the same time, there is a competing purpose concerned with articulating and legitimating a post-abysal methodology which is underpinned by (sometimes ... often) competing ways of enacting rigour, trustworthiness and validity. How to do either, and (or?) both, without losing the power of one or the other, and also without surrendering too much, has been an ongoing challenge. It called for an approach which actively resisted hegemonic prescriptions about what 'good' methodology looked like, while also recognising the legitimacy-making and structural benefits of established hegemonic systems of knowledge production. In the end, this chapter is as much an experiment in commoning as all the others have been - an experiment focused on methodological entanglement towards generating openings which contribute in good ways, to the common good and social-ecological justice.

In an attempt to provide a form of coherence and clarity, while maintaining the 'dance' and 'entanglement' between hegemonic and expansive post-abysal methodological movements, I draw on the metaphor of the Argentine Tango. I use a capital 'T' here to signify the Argentine Tango in its political incarnation with all its accompanying political complexity, rather than referring to the colonised and assimilated tango as a ballroom dance form which is potentially risqué but nonetheless, reconciled within an hegemonic worldview. The Argentine Tango (Tango from here on), according to some narrations, emerged as a subaltern political expression, and an embodied commentary encompassing class politics, the pressures of capitalist productivity and modernisation, immigration politics, and cultural and gender politics (although not necessarily all at once, or for all dancers); it is therefore rooted in a complex hegemonic/counter-hegemonic politics. For Savigliano, Tango is an 'exercise of decolonisation' because of its encounter with the other, which is always relational in nature (2018). Tango is a form of 'counter-text' through which the normalisation and fixing of identity is resisted, and where binary identity constructions are undermined and constantly displaced (Manning, 2007; Gritzner, 2017).

The Tango is a poignant metaphor because it is an embodied enactment of political struggle and complex social entanglements. It is sometimes about one thing and oftentimes about many entangled things. In its improvised form (outside of the colonial and neoliberal structuring of

ballroom or theatrical forms), it can never be pre-determined into a formula of steps in sequence. Instead, it is responsive and transgressive as it is enacted through different bodies seeking diverse expressions (Gritzner, 2017).

Tango here is considered as a subversion of the social framing which it nevertheless needs in order to function; it performs the possibility of a transgression, intimately yet publicly (Gritzner, 2017:49).

Similarly, in the research process I describe below, I attempt to articulate the entangled politics of post-abysal research which arises within a hegemonic system of knowledge production. It is intended to make visible in meaningful ways, the ontological politics (Mol, 1999; Santos, 2004) which permeate all research decisions, as well as open up spaces for onto-epistemic imagination, transgression, resistance and re-imagination as commoning towards social-ecological justice. Implicit in this approach to methodological articulation is the understanding that the post-abysal does not arise in the data, but rather permeates and arises through every aspect of the research process - it is in the *thinking* and the *doing* of this research.

In a political Tango, the two dancers play particular roles: the lead directs and controls the dance through a stiff, structured upper body - a frame; the lead needs to maintain a rigid frame that 'drives' the movements of the second partner, and the dance collapses without this frame and direction. The formalised movements and direction of the dance are controlled through this apparently unyielding structure. Politically, the dominant position of the lead partner represents the bourgeoisie, the patriarchy, the culturally dominant, and other forms of hegemonic dominance. Here, in this context, this lead represents research methodology emerging from neoliberal hegemonic rationality. This includes formalised and normative methodological approaches and systems of rigour and legitimisation.

The Tango is generative - it opens up and generates opportunity and invitation for imagination, creativity and connected responsiveness. Although one partner leads and asserts structure and force into the dance on one level, both partners are required to respond to the others' movements on still other levels, and the second partner maintains a power to subversively re-direct the flow and movement of the dance. In resonance, this methodological outline is intended to open up and support the enactment of a generative system of research, where onto-epistemic imaginaries are provoked throughout the thesis, including here. My concern

goes beyond simply being generative - rather my interest is in enabling generativity towards commoning in the service of social-ecological justice.

As Manning (2007) observes, in Tango, nothing can be known in advance, and every dance is a new encounter, with new horizons of the unknown; so too with this enactment of post-abyssal politics, and with this methodological approach. The approach is concerned with generative methodological openings which enable a rigorous exploration of commoning within the context of this particular study. There is no best practice - no established system of post-abyssal methodology to draw on, although there are examples of such work which inspire methodological insights. Instead, there is a movement between hegemonic structure and post-abyssal, onto-epistemic imagination and political rigour, leveraged in the service of commoning towards social-ecological justice. If I were to repeat this study, no doubt the methodology will have shifted in response to context and evolving systems of entanglement within those contexts. While this study might inform methodological approaches for other studies related to citizen science, replicability is not one of its goals or intentions.

It is also useful to note that Tango dancers are never independent of each other - they are always entangled and implicated in the structures, movements and disruptions of the other, "a constant vacillation between different intensities of touch" (Gritzner, 2017:51). So describing one partner thus, and another as that, is in many ways an artificial distinction intended to draw attention to some movement or feature, rather than a definite way of distinguishing one in contrast to the other. That said, in the politics of Tango, there are unapologetic critiques of the hegemonic, and active freedom-seeking and promotion of the post-abyssal - to recognise entanglement is not to dismiss, soften or excuse the contentious politics and related structures of the hegemonic, but rather to recognise that the lines between the two are not so discrete or independent that they are easily disentangled.

So too, the distinctions in this chapter are never free from their entanglements with each other, and serve to illustrate and point to openings and movements, rather than make hard distinctions or definitively attribute features to one or the other exclusively. The critiques leveraged here and in other places in the thesis are enacted with recognition that not all that is hegemonic is unjust simply because it is hegemonic, nor is the post-abyssal free from similarly contentious politics, power relations or structures. The focus then, is to work with both more consciously, in ways that

enhance communing towards social-ecological justice. This chapter is itself, an attempt at enacting onto-epistemic imagination as an experiment in commoning.

Deepening the metaphor, Tango dancers offer each other signals to support relational movement, as well as ensure openings for responsive movements from the other. Correspondingly, my intention throughout the thesis is to uncover, articulate and explore signals and openings which would deepen potential for commoning and strengthen social-ecological justice in ways which invite response, rather than imposing pre-determined structure.

The second partner either surrenders to or subverts the direction and imperative of the first into a different form of movement, through sometimes cooperative, at others resistant, sometimes subtle, or dramatic shifts in direction. The structure and frame established by the lead dancer are integral to the movements and form of the dance in which the two partners engage; the aim of the post-abyssal movements of the second dancer are not aimed at eliminating those of the first, but rather at reclaiming, expanding and redirecting the dance into forms that are more just, creative and imaginative. It should be noted too, that the lead dancer is as capable of imagination and transgression as the second, but that these are most often expressed in the gaps, invitations and openings afforded through the interaction with the second. The second dancer is not independent of the lead (in the context of the tango between them); the structure and established form provided by the lead dancer provide a base structure through which the reclaiming and post-abyssal steps of the second dancer can be enacted. Where the second dancer might pull into or push away from the lead, the connection is always maintained - they are dancing together. Gritzner points to this connection, noting that the "context in which they connect as social beings is also the place which they seek to transcend in order to enter a relationality of a different kind" (Gritzner, 2017:57).

So too, it would be impossible to write up a post-abyssal narration for this thesis, without also recognising and describing the significant contributions of the structures of hegemonic rationality - this research was in every way, a relationship between the two, even as I more and more strongly sought to resist the hegemonic as the research unfolded and developed. For me, the post-abyssal is not about resisting the hegemonic or eliminating it, but rather about re-imagining it and settling it into new configurations which undermine its dominating tendencies, epistemicides (Santos, 2004), and unjust imperatives, while bringing it into new imaginaries and

relations with other forms of knowing and being. In writing this chapter in this way, I recognise that,

amidst the security that the place of the *milonga* affords us we also create something more abstract, something imaginary: a space of freedom, a momentary line of flight that may reflect a nomadic sensibility, a joy in the experience of flux and in the interplay of placement and displacement (Gritzner, 2017:54).

Practically, I will engage in some visual play to signal the movements between the hegemonic methodologies (aligned left)

and post-abyssal expansions (aligned right)

through the use of two fonts 'dancing' with each other.

4.7. The Tango between Analytical and Political Rigour

"Promiscuity", Childers (2014) argues, "is ontological, a way of being in which the world vibrantly resists understanding even as it is forever entangled in our inquiries". To be meaningful, analytical and political rigour must be conceived of as validity-dimensions of the same research practices. Patti Lather (1986) provides a starting point for strengthening validity in research which adopts an openly ideological approach foregrounding transformative agendas - what she describes as an intention to enact 'research as praxis', which resonates well with my intentions in this section. Lather argues that such praxis-approaches are based on an understanding that, "research which is openly value based is neither more nor less ideological than mainstream positivist research", but is rather overt about its ideology; the shift is an epistemological one which maintains the visibility of a research ideology and works to rigorously manage such ideology; this speaks to Latour (2004) and Santos's (2004) calls for more strongly accountable research and visible researchers (Lather, 1986:64). For Lather, the intention of such an approach is to develop empirical research which both advances emancipatory theory-building and simultaneously empowers the researched (ibid). One of the tasks of validity in such approaches, is to regulate against conceptual over-determinism and self-referential praxis (ibid). Lather (1986:67) describes six validity foci to strengthen overtly ideological research:

- **Construct validity**, which reflexively interrogates theory constructs in relation to the lived experiences of people implicated in such research;
- **Triangulation**, drawing on multiple data sources, methods and theoretical schemes;
- **Reflective subjectivity**, through which a researcher evidences how their assumptions have been affected by the logic of their data;
- **Face validity**, which is concerned with data credibility and an ongoing checking-in with research participants;

- **Catalytic validity**, which refers to a foregrounded interest in both generating a ‘reality-altering impact’, and as importantly, recognises the need to enable research participants to access and make use of insights to gain “self-understanding, and ideally, self-determination through research participation”; and
- **Transgressive validity**, which seeks to change the shape of the thinkable, by making foregrounding “insufficiencies of language and the production off meaning-effects” ... “gestures towards the problematics of representation”, disrupts authoritarian prescriptions through the creation of multiple openings, networks and complexities, and “brings ethics and epistemology together” (1993:685-686).

The interest here is in making research as public and as credible as possible (*ibid*). Below, I describe a range of ways in which the research process speaks to these six validity-dimensions.

4.7.1. Transparency

Because the intention of engaging in a research process concerned with ontological politics is to make ‘knowledge politics’ visible, rigour in this instance, is related to transparency rather than definitive claims about the nature of reality. This is achieved primarily through surfacing contradictions, absences in the form of produced nonexistence, and illustrative data which demonstrate negative spaces (where something is not), openings (where something seems to be or might be), and third spaces (where things are, but in ways which are different to dominant narrations of them).

4.7.1.1. Holding spaces

I use three strategies to increase transparency in relation to ontological politics throughout the thesis. These include holding spaces in the forms of:

- e) *Summaries at the end of chapters, tracking significant shifts between hegemonic and expansive post-abyssal processes of knowledge production - these are held in the form of summarising diagrams;*
- f) *Openings into potential onto-epistemic imaginaries, which are made visible through the use of a contrasting text-font; and*
- g) *Footnotes which note onto-epistemic ambiguities and absences. Some footnotes provide a clarification of the contexts in which I use certain ideas, and others simply point to unresolved ambiguities that fall beyond the direct scope of the thesis, but which nonetheless, require future attention.*

These forms of articulation are intuitive and emerged in my struggles to make visible and enact a more rigorous form of ontological politics, and are therefore experimental and necessarily

incomplete; they should be viewed as openings which tentatively support post-abyssal 'stretching' and expansion, rather than as a definitive methodological technique.

4.7.2. Construct Validity

4.7.2.1. Theoretical rigour and conceptual rigour

Two dominant theoretical perspectives are developed throughout the thesis.

The first draws on internal critiques of systems of legitimated scientific knowledge production, primarily from the field of science studies.

The second draws on decolonial and postcolonial research and leverages external critiques of hegemonic knowledge production which centralise scientific forms of knowledge.

These two theoretical perspectives each offer distinct vantage points with overlapping (although not always) interests. Rigour, in this instance, resolves in the form of converging political-ontological arguments, particularly in relation to ontological rigour and social-ecological justice interests. This might be described as a rigour of theoretical resonance (to echo Law, 2004) or a form of theoretical triangulation. This 'resonance' was achieved through divergent pathways, which began to converge in the latter part of my research process. The resonance that emerged between them did so slowly and from diverse starting points, that later became more intense as I read more deeply into the diverse theoretical arguments, and worked through the data into theoretical explanation. I have also worked to reconcile concepts which overlap different theoretical traditions, so that they provide a coherent conceptual framework for the study which is in alignment with their theoretical underpinnings.

In maintaining integrity with the theoretical framework developed in Chapter 2, I work with the notion of knowledge propositions, openings and signals, and seek to make visible the ways in which I arrived at those propositions, as argued by Latour (2004).

4.7.2.2. Theoretical convergence

An emergent form of triangulation occurred through the convergence of diverse post-abyssal critiques and theoretical perspectives, (including epistemic cultures, decolonial sociologies, capitalocentric critiques, knowledge flow critiques, critiques of dualistic ontologies, etc.). These perspectives converged as the thesis developed, and as I began looking for more robust ways to account for what I was observing in the field of practice, rather than providing an upfront theoretical framework. My intention was never to bring any theoretical perspective into convergence with any other, but rather to use each to enable me to rethink and (re)stor(y)

what I was observing. This strong convergence can be viewed as a form of emergent theoretical triangulation, where each of the post-abysal critiques and perspectives are engaged from diverse starting points, with a range of interests and intentions, but which all contribute to a coherent and converging post-abysal stance.

4.7.2.3. Plugging in

At the start of the study, I designed a theoretical approach which enabled me (I hoped) to collect coherent and usable data to understand knowledge production within the field of citizen science. After the first level of data analysis, I felt compelled to revisit the theories I was drawing on, before engaging in further data analysis. This process of working back and forth between the data and theory was ongoing throughout the process. What I found in the data sent me in search of a stronger theoretical framework, which could account more robustly, for what I was seeing in the data. The renewed theoretical framework likewise, propelled me back to the data, to re-look and engage in yet new layers of meaning-making - I was 'promiscuous' in working between the two, and in searching theoretical explanation to account for what I was surfacing through this dialectic process. Childers demonstrates the power of promiscuous analysis in post-abysal research, noting that "[a] promiscuous analysis has the potential to disrupt the hegemony of systematicity and overcooked conventions often associated with coding in qualitative research" (2014:824).

The process of analysis between different data sources involved two phases. During the second layer of data analysis, I read data emerging from interviews for insights about particular projects, in addition to reading all the interview data together in order to develop an overall view of citizen science practice in South Africa. In the third level of data analysis, I read multiple forms of data 'through' each other, reading for both presence and absence.

At all stages of analysis, I attempted to read data alongside, and 'through' one another through diverse analytical processes (see 4.2). Every reading of data was done through a particular theoretical framing (as described in Chapter 2), and each reading of data read me back to deepening, and significantly shifting the theoretical tools I was using in order to seek more coherent explanatory power. Lather describes this as an aspect of reflective subjectivity, where each encounter with data led me to question and interrogate theoretical perspectives, and ultimately to redesign the study in ways that troubled mainstream explanations emerging from the field of literature (Lather, 1986).

Jackson and Mazzei (2013:261), refer to this process as ‘thinking-with-theory’; this, they demonstrate, results in knowledge being “opened up and proliferated rather than foreclosed and simplified”. They provide a metaphor of ‘plugging one text into another’ to describe how this might be achieved.

Plugging in to produce something new is a constant, continuous process of making and unmaking”, they note. “It is the process of arranging, organizing, fitting together. So to see it at work, we have to ask not only how things are connected but also what territory is claimed in that connection (*ibid*:262).

*‘Plugging in’ is an ongoing process of ‘reading-the-data-while-thinking-the-theory’, iterative and co-constitutive because it creates new ways of thinking about both theory and data, and to keep ‘meaning on the move’ (2013:264). Neither data nor theory is stabilised in this ‘plugging in’ process; rather, each provides a momentary-stability, while being continuously transformed and exceeded. Theory is used to transform data into something different, and data is used to push theory to its limits (*ibid*). The methodological opening here is the enactment of a process which both enables us to use theory/data, and simultaneously, to question the practices that have been available to us even as we enact them (*ibid*). ‘Plugging in’ shifts us away from clean processes of data coding through enacting a conscious ontological politics even as we sometimes code, sometimes enact other forms of analysis with and against the data, and with and against the theory. Mazzei (2014) offers the notion of ‘diffractive analysis’ to describe readings of data which focus on coding and evidencing sameness, towards readings which disperse and disrupt through a process of ‘plugging in’; diffractive analysis intends to keep ‘knowledge on the move’.*

*Such a process, Jackson and Mazzei recognise, is incomplete, and always in the process of being retold and (re)membered. It seeks to actively engage with difference within, by working against easy analysis geared towards identifying sameness (as some approaches to coding promote) (*ibid*). Nor are any categorical similarities and differences treated as comparative, correlational or causal, which they argue, would entrench us in those forms of hegemony which centre and stabilise subjects within hegemonic research approaches; instead there is an active accommodation of multiplicity, ambiguity and even incoherent subjectivity (*ibid*).*

A strong example of this process related to the clear regard that many project managers or coordinators had for citizen scientists. This was evidenced in the ways in which they described the contributions of citizen scientists during the mapping interviews (see 4.2.2.2.). Their energy resisted an easy categorisation of superiority or entitlement, and propelled me to look more deeply into particular epistemic cultures to account for the epistemic bias and normative epistemic statuses I was observing in the field of literature. If professional scientists who were project co-ordinators held high regard for the contributions of citizen scientists to their collective endeavours, then why did it appear that what was being valorised in the

knowledge being produced, diminished and undermined the contributions of the citizen scientists as 'less than'? Counter-hegemonic theories provided one opportunity to open up and broaden my epistemic gaze to include what was invisible, absent or activity produced as non-existent.

4.7.2.4. Analysing for absence

Through their own research findings, Jackson and Mazzei observe that it is those voices which escape easy classification or make easy sense, which provide fertile openings for knowledge work (2013). Rosiek and Heffernan (2014) challenge the validity of atheoretical approaches of data analysis through data coding. They argue instead that produced silences require the use of those theories that offer explanatory power related to the sources and effects of such silences (ibid). Mazzei (2007) argues that a tacit feature of data coding is its privileging of presence over absence, voice over silence, what is seen, heard, read and written over other ways of representing knowing. She argues instead that silence is a worthy data source which is required for the intelligibility of what is being said, and even more, is in fact constitutive of discourse itself. Rosiek and Heffernan add that when "research locates meaning only in what is actually said, expressed, or done, then the absence of expressions, gestures, and voice is tacitly framed as meaningless" (2014:727), and that silences become entrenched when they are 'illegible' to the normative referent. They draw on the metaphor of the artistic mapping of 'negative space' to describe the process of presencing absence (ibid).

While both Mazzei, and Rosiek and Heffernan seek to bring attention to pauses and avoidances in speech, I draw on their work to articulate a larger scope of representational silence or absence, which includes particular forms of absence in some documents, for example, and presence in others. Particular recognitions of process in some descriptions of activity, and their absence in others, and the relations of absence to hegemonic disciplining of knowledge through specific knowledge production processes. Primarily, I do this through an active engagement with modes of produced nonexistence within knowledge cultures. I use diffractive analysis as a way to embrace, and attend to difference by decentering and destabilising hegemonic epistemologies.

4.7.3. Triangulation

In keeping with my post-abyssal interest reflected within this thesis, triangulation is seen as a process of presencing aspects of data that fall outside of traditional research approaches. This approach is cognisant of Lather's (1986) concern of the reciprocally confirming nature of hegemony; it recognises that analysis should not be limited to participants perceptions of their situation alone because "[o]ur common-sense ways of looking at the world are permeated with

meanings that sustain our powerlessness”, and therefore limit the degree to which member-checks might contribute to data validity (ibid:76).

My interest is in both articulating converging patterns from diverse methodological positions, as well as holding space for those forms of knowledge which are sterilised out of the traditional legitimating systems of scientific knowledge production. As such, triangulation in this instance moves away from a focus on data regularity (O'Donoghue & Punch, 2003), towards an interest enhancing depth and breadth of my analytical process through engaging multiple perspectives and analytical processes (Flick, 2004).

4.7.3.1. Analytical triangulation

Analytically, I engaged in the following processes of triangulation:

- a) I collected multiple forms of data related to the same research object, including mapping data (interview-based), peer-reviewed journal articles, research reports, research theses, annual reports, and newsletters. Data was analysed iteratively between the data sources - both for presence and absence.
- b) I analysed data from relatively large data sets, where such data was available. This provided a form of triangulation within each type of data. This included an immanent critique of 65 citizen science journal articles and a field-based mapping of 50 citizen science projects in South Africa (see 4.3.2.2.).
- c) *I also attended a number of workshops, seminars, presentations and symposiums related to citizen science in South Africa. While data were not formally collected during any of these events, it provided an ongoing orientation to the field of practice, and enabled me to discuss the interests and approaches being adopted within the field of practice. A key benefit of this was these events provided an orientation to the field that arose from practitioners, rather than being elicited through my specific research interests. Again, this led to a form of resonance-building between this research and the the field of practice which was being researched.*

4.7.4. Research Ethics, Face Validity, Transparency and Reciprocity

4.7.4.1. Attending to research ethics

Ethical clearance was obtained through the Rhodes University Ethical Clearance Committee at the start of the study. Access was negotiated formally through an introductory letter outlining the research interest in the study (see Appendix 1). More detailed descriptions of additional ethical considerations are outlined in the sub-sections below.

4.7.4.2. Face validity

Face validity was supported in two ways:

- a) For the epistemic mapping process, face validity was achieved as I summarised responses and completed the mapping tool on behalf of respondents - I read back and refined selections and notes as part of the mapping process to ensure that I was representing the projects accurately. This included adding further categories and amending descriptions on the mapping tool where relevant.
- b) Case studies were sent to key informants (where available, at the time of completion). An offer to talk through analysis and findings was included. Two of the case studies (*CREW* and *Khulumani Water for Dignity*) were included as part of a social innovation lab (see below), and provided a chance to share the analysis with citizen science projects, including a team from *CREW*.

The CREW team were invited to actively comment on and add to what was presented from their case study during the session, which they eagerly did; I intentionally created space for them to lead discussion points as part of my presentation preparation.

4.7.4.3. Transparency

A standard approach for securing informed consent from research participants is generally done with a permission form signed before a research interview or observation begins. My approach was to orient interviewees to the permission form at the start of the interview. Interviewees completed the form at the end of the interview process, so that they were fully aware of what they were conceding to before signing the forms (see Appendix 2). Included in this process was permission to use their names as references to data extracts from their interviews. They were given the option of anonymity if desired, and again, only made their decision at the end of the interview process. Each of the interviewees chose to include their data in an open database, and to be directly referenced. The only exception was one project which requested only that the details of their project funders be excluded from any database. This contributes to Latour's call to maintain the visibility of knowers and knowledge producers (2004), in addition to providing an initial contribution to the epistemic justice (see 1.3), that Santos (2004) calls for.

4.7.4.4. Reciprocity

Reciprocity was seen as an important ethic within the research process. Citizen scientists provide voluntary contributions to the common good; I felt an ethical imperative to likewise reciprocate to their efforts as an integrated aspect of my research design. While catalytic validity (Lather, 1986) fell beyond the scope of my research design, mechanisms for reciprocity provided fertile openings towards possible catalytic outcomes. Within the research process, reciprocity was designed through:

- a) *The inclusion of practice-related data that was not necessarily of interest in this study as data, but which would be of interest to the other practitioners engaged in citizen science in South Africa (Project contact details, affiliated partners, types of funding, challenges and barriers, lessons learnt and recommendations);*
- b) *Negotiation of open data, as described above. Open data is available on request and was intended to support further practice and research-based development in the field.*

Practice-Based Social Innovation Labs: In addition, in partnership with the other scholars engaged in citizen science-based research within our community of practice, we developed and ran two social innovation labs. Through the labs, we piloted a process for translating research findings into usable practice-based tools for citizen science projects. The process used to design the labs was based on a dialectic model of critical reflection. Participants ‘thought’ and ‘viewed’ their projects through the insights and tools arising from research findings across the studies. The intention was to collaborate with projects around new ways to think about and develop their commoning work, rather than imposing a set of theoretical beliefs onto them. Included in this process were:

- a) Two social innovation labs, to which we invited as many citizen science projects as we had contact details for. Projects were encouraged to send teams which included citizen scientists, and were fully funded;
- b) *A set of practical creative commons resources, which lab participants used during the labs, and which were then available for them to use more widely within the projects, and to share with other projects. The resources were substantially revised based on feedback from lab participants, and will continue to be developed as they are used in practice;*
- c) A project resource site was also developed to host the resources, in addition to collecting together other resources of interest to citizen science projects.

(<https://citizensciencelab.weebly.com>)

4.7.4.5. Co-authorship of open research

- a) *It is my intention to co-author open access peer-reviewed journal articles with citizen scientists from each of the three case studies (as those which have been analysed in depth). This is yet to be negotiated at the time of writing this chapter, but has been discussed with representatives from two of the projects so far.*
- b) *My further intention is to privilege open-source journals as sites for publication of any research articles arising from this study, where possible.*

4.7.5. Areas of 'Thin' Rigour

4.7.5.1. Lack of data from key epistemic subjects

An area of 'thin' rigour in this thesis is a lack of key informant data from many of the knowers identified in the final data chapter (Chapter 7) of the thesis. Their exclusion was pragmatic, and based on the non-feasibility of collecting additional data to inform an already substantive study. However, while pragmatic, their exclusion is significant within the context of the arguments forwarded through the thesis. This is an area in which the work of ontological politics pursued in the thesis is weak: these perspectives are primarily reflected through their absence, and through official, written channels. Many of the authors cited in the theoretical and conceptual frameworks of this study critique such approaches to representation. A more appropriate form of rigour, from this perspective, would have been to prioritise engaging data generation processes which privileged knowledge-coproduction and co-representation.

4.7.5.2. Beyond the written word

The thesis is written in a scientific-academic form for the most part. This includes complying with referencing styles and a linear structure with standard sections (theory, methodology and data chapters), and I adhere to all of the conventions of assembling a thesis, as practiced within the community of practice I am situated in.

However, as Gritzner points out Tango is,

[c]onsidered as a spectacle (from the perspective of those who watch others dance), tango relies on various modes of framing and representation which, however, do not readily communicate its essential power of in-definition and its often elusive nature (2017:57).

In maintaining a post-abyssal stance to epistemic expansion, I recognise and wish to 'write out loud' that many of the most significant energies emerging from this research process are not reducible to written words - the words can only ever offer signals and retrospective attempts to describe the deeper processes of the shifts which occurred both for me personally, and more broadly within the practice spaces in which these research process and insights have some impact. This acknowledgement is a form of rigour which maintains a political awareness of representation, and especially written representation, and recognises that the words can never contain all that has come to be known through the social process of thinking and doing research in the context of practice. While the flow diagrams included go some way towards providing a relational view of various aspects of the thesis, much remains that could not be captured in a textual format. While I recognise the hegemonic tendency to elevate written accounts over other forms of representation (Goody, 2006; Law, 2004), I also acknowledge that I have not been able to provide a broader form of representation in the scope of this study.

4.7.6. Researcher Positionality

Argentine tango is a somatic practice of connection and mindfulness. It is also a symbolic practice of expenditure and self-transformation, which requires a great amount of patience, personal investment and intuitive 'labour' because the progress of learning this dance is slow (Gritzner, 2017:55).

In tango I discover a different modality of freedom and self-expression: A sense of self as lacking strict containment or firm boundaries; a self that is relational, a becoming-self. I learn how to stand on my own axis, how to express my own autonomy in the encounter with another body, but also how to honour the power and need for connection, the desire for being-with the Other (Gritzner, 2017:58).

In troubling 'the problem of speaking for others', Linda Alcoff (1991) challenges us to think more accountably about the ways in which we take up representation for others. She argues that a person's social location or identity has epistemic saliency on that speakers claims in ways that either authorise or de-authorise what is being said (Alcoff, 1991). She observes that,

[a]s philosophers and social theorists we are authorised by virtue of our academic positions to develop theories and express and encompass the ideas, needs, and goals of others. However, we must begin to ask ourselves whether this is a legitimate authority (Alcoff, 1991:7).

Her concern is both epistemic and political because such representations are inevitably mediated and therefore the products of interpretation (Alcoff, 1991). She argues that it is not enough to adopt a clean set of rules about if and when it might be appropriate to represent others; instead she calls for us to attend to the political implications of our representational choices (both for ourselves, and for those we seek to represent). She points out that, "[w]ho is speaking to whom turns out to be as important for meaning and truth as what is said", and instead calls for a responsive and accountable process of engaging in issues of representation (Alcoff, 1991:12). Ontological politics (Mol, 1999) in this instance, "requires us to shift the ontology of meaning from its location in a text or utterance to a larger space, a space that includes the text or utterance but that also includes the discursive context" (Alcoff, 1991:12).

Underpinning this politics is the understanding that meaning is plural and shifting in light of the ability of a single text to engender diverse meanings and political implications within diverse contexts, and this in turn affects the epistemic status of what is being represented (Alcoff, 1991). Alcoff argues that it is insufficient to simply ensure that sufficient research has been done to justify claims, but that the contexts of both research and the utterances that arise out of research are politically charged. She points out that,

Certain contexts and locations are allied with structures of oppression, and certain others are allied with resistance to oppression. Therefore all are not politically equal, and, given that politics

is connected to truth, all are not epistemically equal [...] Who is speaking, who is spoken of, and who listens is a result, as well as an act, of political struggle (Alcoff, 1991:15).

The implication of this, as Alcoff (1991), Santos (2007), Latour (2004), Law (2004), Lather (1986) and others point out, is that there can be no epistemic evaluation of truth claims without an accompanying assessment of the politics within which such truths are to be enacted. This is demonstrated more explicitly in the three critiques presented in Chapter 3. To speak for others then, is to do more than acknowledge we are doing so. It requires a self-reflective and accountable way of speaking which recognises both that we are inextricably entangled in the social and material fabric of the world, while also recognising that we can never fully mediate the experiences of those we choose to represent.

Alcoff proposes one way to 'speak for others' which might engage in an active form of ontological politics, which is to: "strive to create wherever possible the conditions for dialogue and the practice of speaking with and to rather than speaking for others" (Alcoff, 1991:23). Rosiek and Heffernan (2014) point out that a community is unable to imagine nor discuss what they have no words or concepts to think about, and that such lack is likely to lead to a practice phenomena going unnoticed, unremarked on, and therefore, absented. For me, they are describing the benefits of researcher (and her research) as mirror; my intention is to play the role of mirror in ways that provide fertile openings to notice and speak with each other, about what is present and what is absent in our community of practice.

However, Alcoff (1991) also points out that the very structures of discursive practice are problematic, and that there is work to be done on altering these structures themselves, in order to open up possibilities for denigrated others to speak for themselves⁸¹ (*ibid*). Her central argument is that in choosing to speak for others, we need to evaluate the possible effects of our words on particular contexts, one must examine where the words go and what they do there. She insists that the "content of the claim, or its meaning, emerges in interaction between words and hearers within a very specific historical situation", and that being accountable requires that we attend to the impacts of these interactions - a perspective which resonates with Latour's call for presence and accountability, and Santos's demand for translation (Alcoff, 1991:26).

⁸¹ One way in which I will be taking this forward is through the collaborative generation of geo-stories which are co-constructed with citizen scientists. Funding has already been secured for the first shared experiment in doing so, which will include three citizen science projects.

At a practical level, I have chosen to narrate this work in an active voice, so as to maintain both my own agency, as well as accountability for what I have written; recognising that to claim neutrality and objectivity is both ontologically incoherent, as well as inaccurate (Alcoff, 1991; Latour, 2004). This maintains the rigour Latour (2004) calls for when engaging with 'matters of concern' where spokespersons of knowledge work are required to maintain their visibility, and remain accountable and responsible for their knowledge claims even while offering them in service to a good common world, and to make visible the propositional nature of what they offer into such service. My intention, then, is not to define or redefine truth-claims, but rather to gather a movement of post-abysal propositions which contribute (from the insights emerging through this particular research process), to strengthening systems of commoning towards social-ecological justice, and related arrays of common goods. As an educator-activist and citizen of the Earth, I aim to engage in a process of politically and analytically rigorous generativity which I hope will provide a more fertile knowledge context for commoning.

I became aware late in the research process that I enacted many of the very research practices which I critique through the thesis. While I have done my best to attend to such critiques in those forms possible at such a late moment in the research journey, I am also undeniably implicated in perpetuating them. More plainly, I hold the authoritative position as the sole author of research design, and analyst of data. While the agenda foregrounded in this research arose out of the collective experiences of a global community of practice, still the specific agenda is my own, unmediated nor negotiated with those contributing too, and participating in, the research process. I am speaking for myself in this thesis as Earth-citizen and practitioner, but I am also claiming an authoritative position as a legitimate spokesperson for citizen scientists and environmental educators in ways which I have come to perceive as at least partially troublesome. My response has been to foreground political ontology and begin the task of learning how to engage in post-abysal research (rather than claiming any form of authority as such a researcher). I chose not to re-start the research process for my own pragmatic reasons, and I recognise that this research decision in many ways undermines my deepening intention to engage in politically robust ways of enacting post-abysal research. It is my hope that my approach of propositional openings and enacting onto-epistemic imaginaries mediates to some degree, the hegemonic knowledge forms within the thesis.

Tango is not a formless expression of uncontrollable passion, but a desire with a rhythm shaped by the form of the dance. There is a shape to my dancing desire, a rhythm, and I have to attune

myself to it and to the realisation that differences and tensions remain unreconciled (Gritzner, 2017:58).

An extension of accountable 'speaking for' is accountable listening; this involves both engaging with the politics of my own position as speaker, as well as listening for which stories or versions of stories are being told, and which not. Chapter 7 demonstrates in action, what this looks like in the specific contexts of three illustrative cases (especially when read in light of the critiques in Chapter 3). At a broader level, this is indicated by the onto-epistemic imaginaries opened up throughout the text, which seek alternative ways to think and know. My intention is not to tell the stories of the citizen science projects investigated through this research, but rather to tell my story in ways that provide a reflective mirror for those engaging in related work. As Jackson and Mazzei (2013) model in their work, the 'speaking for others' and especially the analysis informing such representation aims to become '*something else*'.

4.8. Conclusion

In this chapter, I outlined the reflexive methodological design enacted in this study. The chapter was written as a post-abysal experiment in methodology-as-commoning. A concern for ontological rigour was centred, in addition to describing measures undertaken to ensure analytical rigour. Another strong intention in writing this chapter was to make at least part of the messiness and always-uncertainty of this research visible to the reader. Figure 18 below summarises the post-abysal expansions generated in this chapter.

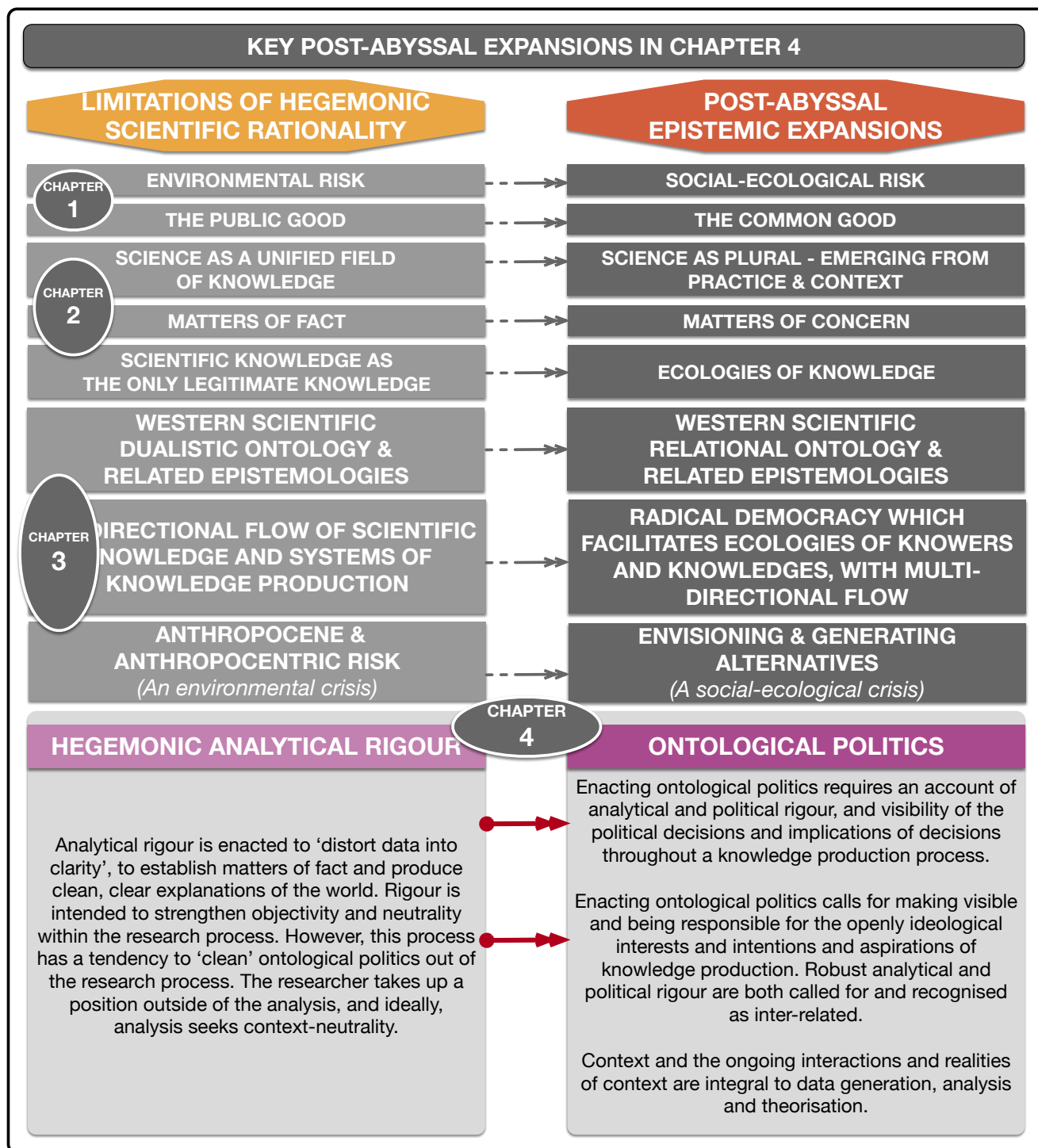


Figure 18: Visual Summary of post-abyssal expansions in Chapter 4

KEY INTER-RELATED CONCEPTS LEVERAGED IN THIS STUDY

This concept map highlights key concepts leveraged in this study, and maps their relations to each other. References to more careful articulation of each concept are indicated on the right of each definition.

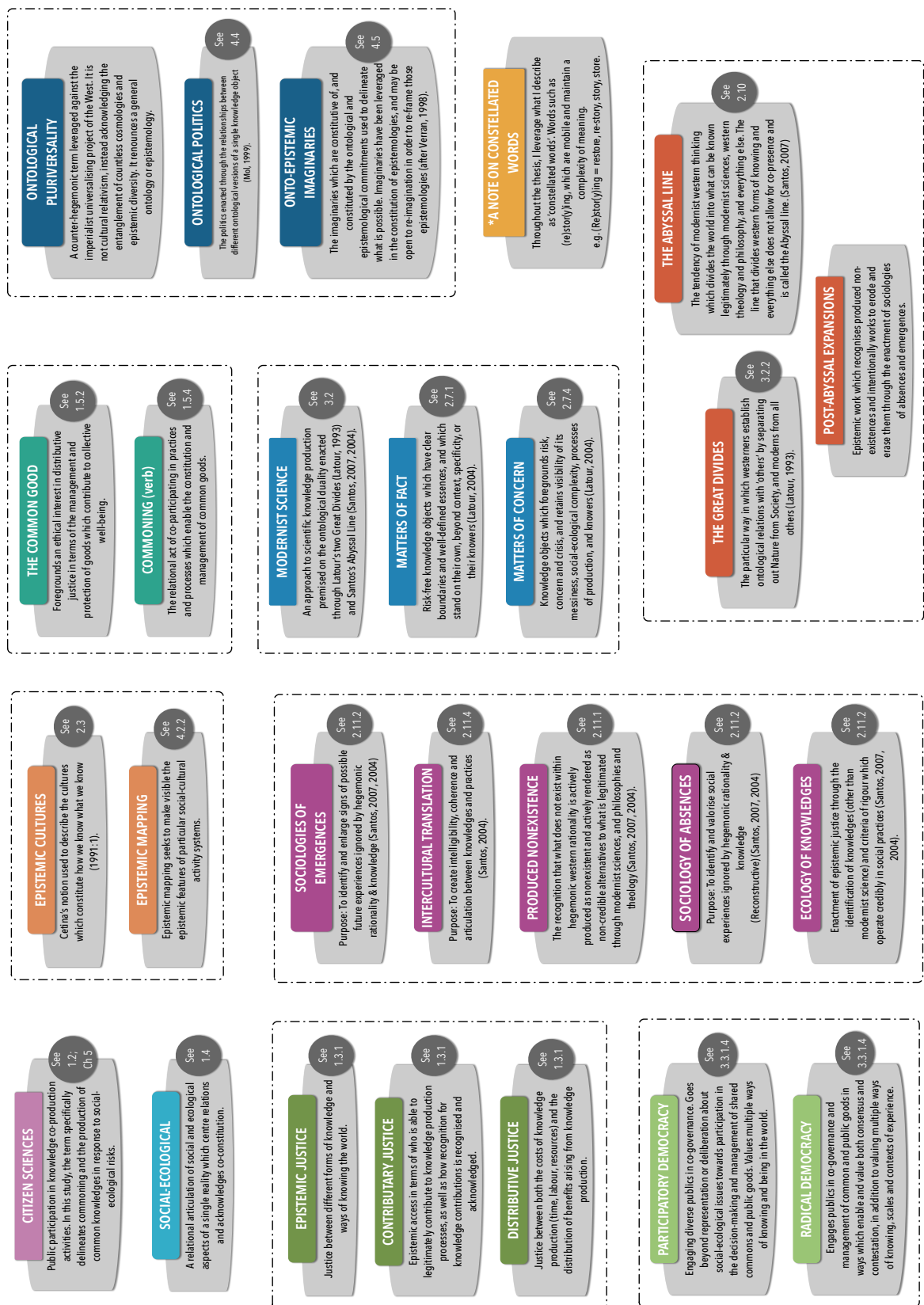


Figure A. Key Inter-related concepts leveraged in this study

CHAPTER 5

(Re)presentations of Citizen Science in Peer-Reviewed Literature: Presences and Absences

[n]eo-liberal globalization is presided over by techno-scientific knowledge, and owes its hegemony to the credible way in which it discredits all rival knowledges, by suggesting that they are not comparable, in terms of efficiency and coherence, to the scientificity of the market laws (Santos, 2006:13).

5.1. Introduction

As I worked across literature and practice-based analytical data emerging from South African projects, and developed a 'cultivated gaze'⁸² for noticing produced nonexistence, a range of disjunctures and absences in much of the published literature on citizen science became perceivable. In addition, there appeared to be a conflation in the ways authors reported on knowledge production and learning. In order to engage with these absences more rigorously and systematically, I chose to redo the initial literature review with the specific intention of identifying and engaging with epistemic absences and presences. In effect, selected peer-reviewed journal articles became data to be analysed for presence and absence. To this end, I combined the analytical perspectives outlined in Chapters 2 and 3 (see 4.6), and engaged within Chapters 6 and 7, so that I could re-look at the literature through the study's theoretical framework. Methodology is described in 4.2.4.5., a copy of the analytical tool can be found in Appendix 5, and a tabulated list of journals from which papers were sourced is included in Appendix 10.

There is already a substantial field of literature in the arena of citizen science available across a wide range of journals. This review centers peer-reviewed literature which focuses on the theory and practice of citizen science, rather than reporting scientific findings emerging through the application of citizen science methodologies. Only papers specifically using the term 'citizen science' to describe epistemic practices were included, even though there are a number of other phrases leveraged to describe the same, similar or overlapping areas of practice. I have attempted to lift key trends and tensions within the literature (based on insights emerging from the analytical process), rather than offering an exhaustive analysis. The primary interest in this chapter is to gain insight into why and how particular forms of epistemic practice are mostly absent in the literature, while others are foregrounded. Also included is a brief orientation to the citizen science associations which have emerged over the last two decades. They are included because they are perceived as some of the strongest collective drivers of epistemic activity globally, and are strongly associated with a range of epistemic objects.

⁸² This gaze was 'cultivated' was informed by previous chapters and the analytical tools emerging from them, as I worked across theory, methodology and data, and was most strongly influenced by the work of Santos (2004). I found that as I was engaging with data, I became aware of certain gaps. This led me to a more intentional analysis around absence.

Two general approaches to thinking about and reporting on citizen science emerged in the literature, one maintaining hegemonic accounts of knowledge production that privileged modernist scientific knowledge production, and the other engaging a more strongly post-abysal (re)presentation and expansion of citizen science. Recognising that each approach is part of a collective conversation about the epistemic legitimacy, possibilities and enactments of citizen science, I chose to present them as such - two sides of a single conversation (as framed in 2.7-2.9, and resonating with the methodological Tango presented in 4.7, and the expansive work of articulating ecologies of knowledges in Chapter 7).

More strongly hegemonic accounts are indicated through left font justification,

while more expansively post-abysal are justified right.

5.2. Opening the Field: Two Related Conceptualisations

The distinction of the field of practice referred to as 'citizen science' is attributed to two almost simultaneous, yet independent conceptualisations. These two texts, between them, exemplify the two epistemic approaches prevalent in peer-reviewed literature about citizen science.

The first is by Alan Irwin (1995), through his book entitled Citizen Science: A Study of People, Expertise and Sustainable Development. Irwin's interest is in understanding the different ways in which we enact scientific citizenship in response to social-ecological risk, especially in terms of the production of sometimes contradictory or confrontational knowledges between institutionalised systems of knowledge production (including institutional arrangements at the science-policy-industry interface), and knowledges generated by citizens situated in, and affected by, contexts of risk. In this framing, citizen scientists are knowledge producers in their own right who might produce knowledges which adopt counter-cultural stances to institutional narratives of risk, thereby generating post-abysal accounts of knowledge-in-relation-to-risk. Knowledge production expands beyond public good discourses, to include notions of common goods, and how such goods might be constituted. Explaining the coining of the term, Irwin says,

I chose it because it conveys both senses of the relationship between science and citizens ... 'Citizen Science' evokes a science which assists the needs and concerns of citizens ... At the same time, 'Citizen Science' implies a form of science developed and enacted by citizens themselves (Irwin, 1995:xi).

The second is by Rick Bonney (1996), in an article entitled *Citizen Science: A Lab Tradition*, in which he described a range of ornithological studies involving volunteers in monitoring activities. Bonney's orientation to citizen science is one in which citizens make meaningful contributions to established systems of biodiversity monitoring, and through such contributions, gain scientific literacy and

hopefully contribute to biodiversity conservation. Hegemonic modernist knowledge production processes are maintained and citizen scientists are recognised as making valuable contributions through established epistemic and institutional arrangements. Knowledge production is more strongly framed as a public good which is governed through institutionalised systems of knowledge production on behalf of the public. Bonney first conceptualised citizen science in this way:

The Lab of Ornithology depends on amateurs to collect data. But citizen science is a two-way street: Participants gain from the projects, too. ... amateur ornithologists become proficient in bird identification, acquire skills of patient observation, imbibe the process of scientific investigation, and gain the satisfaction of furthering scientific knowledge. The Lab also hopes that public participation in bird studies will spawn action on behalf of birds (Bonney, 1996:7).

There are also older accounts of the term being used in various media articles.

Strasser et al.⁸³ (2019) also highlight a more historical use of the term in relation to radical science movements and their critiques of science, in the 1960s and early 1970s. These movements aimed to educate scientists about various social justice issues related to scientific knowledge production. Through awareness-raising, scientists in radical science movements hoped to make professional scientists better citizens, or “citizen scientists”, rather than military or industrial scientists, for example (*ibid*). However, the epistemic roles and status of professional scientists were maintained as epistemically superior to their publics in these movements. Strasser et al. point out the divergence between this historical framing, and current framings of citizen science, noting that,

[t]oday, the “citizen scientist” is no longer a professional scientist behaving like a responsible citizen, but a lay citizen who acts like a scientist, specifically in producing scientific knowledge (although the idea of the responsible scientists may still apply to the organisers of participatory projects) (*ibid*:61).

5.3. Institutionalisation of the Field of Practice

Between 1995 and present day, the term ‘citizen science’ has seen rapid uptake across a range of disciplines and fields of practice. This resulted in the institutionalisation of citizen science as a knowledge production methodology, and has given rise to a range of formal institutional arrangements, including policy mechanisms and associations, as well as a field-specific journal. There have also been various attempts at formal definition.

83 Strasser, B., Baudry, J., Mahr, D., Sanchez, G., & Tancoigne, E.

5.3.1. Defining Citizen Science

In 2014, almost a decade after the term appeared in the fields of ornithology (after Bonney) and public science (after Irwin), the term was entered into the Oxford English Dictionary as a sub-entry (OED, 2014), and excluding any reference to education or learning, citizen science was defined as,

scientific work undertaken by members of the general public, often in collaboration with or under the direction of professional scientists and scientific institutions.

A second sub-entry was entered for citizen scientists, who were defined as,

- (a) A scientist whose work is characterised by a sense of responsibility to serve the best interests of the wider community (now rare); or
- (b) A member of the general public who engages in scientific work, often in collaboration with or under the direction of professional scientists and scientific institutions; an amateur scientist.

The Marrian-Webster online dictionary currently contains no entries on either ‘citizen science’ or ‘citizen scientist’, but the Cambridge Dictionary (2021) defines ‘citizen science’ as,

scientific work, for example collecting information, that is done by ordinary people without special qualifications, in order to help the work of scientists

and Macmillan Dictionary (2021) defines it as,

the collection of scientific data from observations made by the general public.

These definitions align more strongly with Bonney’s (1996) framings than those offered by Irwin (1995), maintaining hegemonic understandings of the role of citizen science in processes of knowledge production. They have also excluded any reference to public participation, education, outreach, learning, or collaborative processes of knowledge production, instead entrenching hegemonic delineations between science and publics (see 3.3.) , and confining the epistemic roles of citizen scientists to various forms of data collection for professional scientific research.

Heigl *et al.*⁸⁴ (2019), for example, argue for a definition of citizen science based primarily on the rigour and integrity of scientific knowledge production. Rather than providing one overarching statement of definition, they suggest the application of a catalogue of seven assessment areas which include 20 criteria. Assessment areas include what is excluded, scientific standards, collaboration, open science, communication, ethics and data management. Each of these categories is in relation to hegemonic knowledge production systems. Interestingly, the authors’ central argument regards strengthening trustworthiness in citizen science data, and includes an argument that all citizen science data should be open (barring legal or ethical barriers), and that scientific transparency is critical to trustworthiness. Transparency includes communication and transparency about knowledge production methodologies and purposes between scientists and citizen science volunteers. Ethics are framed only in terms of scientific institutional systems of ethics. Diverse scientific knowledges are acknowledged,

84 Heigl, F., Kieslinger, B., Paul, K. T., Uhlik, J., & Dörler, D.

but all other forms of knowledge remain invisible, both in their paper and in the original quality criteria (Heigl *et al.*⁸⁵, 2018).

The *Ten Principles of Citizen Science* are another attempt to define, delineate and even govern what counts as citizen science. The principles were defined by a working group on 'Sharing best practice and building capacity for citizen science' within the European Citizen Science Association (ECSA) (Robinson *et al.*⁸⁶, 2018). The influence of these principles can be seen in the discourses about citizen science within various institutional arrangements, and epistemic objects within Europe especially. A range of case studies documenting uptake of these principles is also being compiled, including a US policy brief on crowdsourcing, citizen science and public participation techniques (*ibid*).

The Ten Principles of Citizen Science (Robinson *et al.*, 2018:29)

1. Citizen science projects actively involve citizens in scientific endeavour that generates new knowledge or understanding;
2. Citizen science projects have a genuine science outcome;
3. Both the professional scientists and the citizen scientists benefit from taking part;
4. Citizen scientists may, if they wish, participate in multiple stages of the scientific process;
5. Citizen scientists receive feedback from the project;
6. Citizen science is considered a research approach like any other, with limitations and biases that should be considered and controlled for;
7. Citizen science project data and metadata are made publicly available and where possible, results are published in an open-access format;
8. Citizen scientists are acknowledged in project results and publications;
9. Citizen science programmes are evaluated for their scientific output, data quality, participant experience and wider societal or policy impact;
10. The leaders of citizen science projects take into consideration legal and ethical issues surrounding copyright, intellectual property, data-sharing agreements, confidentiality, attribution and the environmental impact of any activities.

As can be seen, the ten principles delineate a hegemonic notion of what citizen science is. The production of scientific knowledge is centralised, as are scientific systems of rigour (note principles 1, 2, 4, 6, and 10 in particular). The principles also seek to establish more open systems of scientific knowledge production, which attend to issues of contributory and distributive justices in some ways (see principles 3, 4, 5, 7, and 8 in particular), but issues of epistemic justice remain absent.

⁸⁵ Heigl, F., Dörler, D., Barta, P., Brodschneider, R., Cieslinski, M., Ernst, M., Fritz, S., Greilhuber, I., Hatlauf, J., Hecker, S. and Hübner, T.

⁸⁶ Robinson, L. D., Cawthray, J. L., West, S. E., Bonn, A., & Ansine, J.

However, formal definition of what precisely citizen science is and includes remains hotly contested, and continues to be debated.

In 2017, authors from diverse fields of citizen science practice attempted to articulate the complexity and ontological politics of the task of definition, in a paper entitled 'Citizen Science Terminology Matters' (Eitzel et al.⁸⁷, 2017). The authors warned about hasty definitions, and systematically articulated a range of ontological politics and their implications in defining a complex landscape of epistemic practices. Their account included theoretical, historical, geopolitical and disciplinary influences, considerations and blindspots, and they considered epistemic purposes, roles, objects, relationships and outcomes in their analysis. The authors point out that,

[b]ecause citizen science is a form of knowledge production, citizen science terminology has the power to allow some peoples' knowledge to be included and the knowledge of others to be excluded (ibid:4).

Recognising that "what we call things is linked to what we think they are", their conclusion was that no single term or definition was appropriate for defining all contexts of practice associated with the concept of citizen science (ibid:2).

5.4. New Epistemic Institutions and Institutional Arrangements

The nearly two decades since Irwin (1995) and Bonney's (1996) articulations of citizen science have seen the emergence of new institutional arrangements arising in response to citizen science practices. These include shifts in policy, uptake into governance and knowledge mediating structures such as the United Nations Environmental Programme (UNEP), as well as a range of associations for citizen science, conferences, and a dedicated journal. Each of these mediate epistemic activity in diverse ways.

5.4.1. Citizen Science in the Policy Landscape

In their review of policy conceptions of citizen science, Hecker et al.⁸⁸. (2019) note that the term 'citizen science' is becoming a legal one, evidenced through its inclusion in a range of legal structures and policy documents. The following summarises key findings from their analysis:

- Several of the policy documents analysed included scientific input of one kind or another (*ibid*), making visible the knowledge translation systems between science and policy;

87 Eitzel, M.V., Cappadonna, J.L., Santos-Lang, C., Duerr, R.E., Virapongse, A., West, S.E., Kyba, C.C.M., Bowser, A., Cooper, C.B., Sforzi, A. and Metcalfe, A.N.

88 Hecker, S., Wicke, N., Haklay, M., & Bonn, A.

- The majority of policy documents define citizen science in resonance with Bonney's (1996) definition, rather than Irwin's (1995).
- Citizen science is embraced in a variety of approaches and levels of engagement (epistemic purposes, roles, and relationships), although these are mainly concerned with biodiversity and environmentally-related tasks;
- Citizen science is also often coupled with discussions about open science and crowdsourcing, with digital technologies being perceived as one of the main drivers of this form of knowledge production;
- Citizen science is often conceived of as an inclusive approach to joint or participatory research connecting academia and societal actors, and is linked to education;
- Interlinkages with lay, local and traditional knowledges are rarely mentioned;
- Educational interests are only superficially discussed, compared to scientific and policy interests; and
- Definitions of citizen science appeared to be consistent across different parts of the world.

The analysis shows a particular positioning of citizens in relation to the science-policy interface, one which emphasises only particular forms of public participation; discourse about participatory and radical forms of democracy, and of knowledge aims outside of science-policy structures remain absent.

Two examples of policy representation include UNEP's *2014 Year Book*, and the more recent *GEO6 Report - Chapter 25* (Daguitan et al.⁸⁹, 2019), and the *White Paper on Citizen Science for Europe* (Sanz et al.⁹⁰, 2014). Between them, these documents illustrate particular orientations towards citizen science which resonate with the findings of Hecker et al. (2019).

In 2014, the *UNEP Year Book* described citizen science as public participation in one or more aspects of scientific research in ways that helped researchers to obtain 'wide perspectives and deep data'. In addition, participating in citizen science is also noted as a way to raise awareness, increase local interest, and contribute to more informed policy decisions. The short piece attempts to represent the diversity of potential applications of citizen science, from species mapping and the production of scientific research, to applied resource management using indigenous knowledges (*with a focus on epistemic, contributory and distributive justices*), to awareness-raising. Absent in the descriptions of citizen science, are education and learning, or the creation of common knowledges. The entry article

⁸⁹ Daguitan, F., Mwangi, C., Tan, M., Clark, G., Cooper, D., Donovan, J., Gutierrez, S., Kruglikova, N., Lehoula, P., Deager, J., Sonntag, W. & Patel, M.

⁹⁰ Sanz, S., Fermin, Holocher-Ertl, T., Kieslinger, B., Sanz Garcia, F. & Silva, C.G.

maintains hegemonic institutional arrangements related to scientific knowledge production in many ways, positioning citizen scientists as contributors to the knowledges which scientists and project developers build (even where such contributions include indigenous knowledges).

This initial narrative remains evident in more recent UNEP reports referencing citizen science. For example, Chapter 25 within the *GEO6 Report* (Daguitan *et al.*, 2019) focuses on future data and knowledge needs in relation to the sustainable development goals. The report speaks to three core areas, one of which is citizen science. Citizen science is defined in terms of volunteer engagement in science and research, and the primary benefit is noted as the collection of “data over wider spatial coverage and longer periods at lower costs” (Daguitan *et al.*, 2019:599). The account of citizen science is hegemonic in nature, crediting American projects as the oldest projects⁹¹, with a focus on top-down projects which are institutionally-mediated, or bottom-up projects which require professional translation.

The top-down approach is mostly driven by scientists who train volunteers on the procedures and the research to be undertaken. Based on this approach, the volunteers play limited roles mostly in data collection. The bottom-up approach is driven by the community. More often than not, this is driven by the need of the community to understand or gather evidence of a concern. The community can then approach scientists for support and guidance during the process (Daguitan *et al.*, 2019:600)

The intention to integrate citizen science approaches into global SDG monitoring processes was supported by the launch of UNEPlive - an online data collection portal convening various forms of monitoring data.

One of the most referenced policy documents on citizen science is the *White Paper on Citizen Science for Europe* (its predecessor, the *Green Paper on Citizen Science for Europe*, is also often referenced). The White Paper defines citizen science as,

general public engagement in scientific research activities when citizens actively contribute to science either with their intellectual effort or surrounding knowledge or with their tools and resources (Sanz *et al.*, 2014:8).

The White Paper aligns with Bonney’s (1996) notion of citizen science, foregrounding the production of scientific knowledge and methodologies. The White Paper was informed by a research process concerned with improving citizen engagement in science, and articulates a range and diversity of citizen science approaches related to this goal. It also promotes stronger scientific and social values over economic ones, arguing for structural reforms which increase openness and a diversity of actors (Sanz *et al.*, 2014). The policy outlines proposed actions and five forms of support measures, articulated at macro (policy frameworks, policy makers, and science funders), meso (citizen science

⁹¹ This is an inaccurate timeline, with substantively older projects recorded in China and Japan (Tian *et al.*, 2011; Primack *et al.*, 2009), as well as several regions in Europe.

mediators and facilitators), and micro (research groups, communities and citizen science organisations) levels. It advises on a range of actions which are geared towards stronger alignment between citizen science projects, and State and academic institutions (with a focus on engaging modernist scientific enactments of knowledge production).

The paper's primary focus seems to be on enabling future systems of scientific productivity which align citizens and State systems towards established forms of scientific knowledge production. The only systems of legitimation outlined are scientific, speaking to data quality, coherence, replicability, shareability, and trustworthiness, with a focus on standardisation across epistemic systems. There is a stronger focus on technology-mediated forms of citizen science, with little mention of enabling other forms of civic action which do not centralise the production of scientific knowledges, use of digital technologies or alignment with State infrastructures. There is also a clear distinction between science (knowledge outcomes) and social outcomes or impacts of projects (anything outside of scientifically legitimated epistemic activities). While local contexts and community-based initiatives are mentioned, there is no acknowledgement of other forms of knowledge. Interestingly, the first support measure across all three levels is Education (macro, meso and micro levels) - Training and Learning, which focuses on strengthening systems of induction, geared towards active citizenship (particularly in regards to the production of scientific knowledges) at the macro level, systems of scientific literacy at the meso level, and school-based curricular support for science learning at the micro level.

However, the authors also promote the development of institutional structures which more democratically engage with knowledge produced in bottom-up systems. Additionally, there is much focus on mechanisms of openness (data, systems of funding and knowledge production, and technologies, as well as framing a concept of professional scientists which echo the descriptions of radical science movements and their notions of "citizen science" (Strasser et al., 2019).

Overall, the White Paper institutionalises a very specific conceptualisation of citizen science - one which foregrounds only scientific knowledge production, and positions citizens in relation to this system. Although there is some indication of participatory democracy discourses, these are limited to processes mediated by scientific and State institutions. The policy maintains the hegemony of scientific knowledge production, while facilitating processes of induction and alignment across systems of activity.

As evidenced, the policy landscape seems to be more strongly aligned with notions of citizen science forwarded by Bonney (1996), further entrenching hegemonic systems of knowledge production. It is also useful to note that citizen science is being leveraged in response to calls

from research funders (especially those with policy and governance connections) to include public engagement. Citizen science provides a way to engage publics in research although this is often conflated into a cost-benefit analysis of citizen scientists as a low-cost or voluntary labour force, rather than as a mechanism for enabling participatory or radical democracies. This raises concerns about the potential of citizen science to undermine what should be a call for deeper and more authentic levels of democratic participation. Funders and policy writers might need to more carefully articulate what counts as participation, as well as providing a range of participation options, based on the purpose of both research and participatory approaches to research.

5.4.2. Citizen Science Associations as Convening Epistemic Institutions

In response to the definition of a new (or at least renewed) field of epistemic practice, a range of convening epistemic institutions and organisations have risen. Although there are few peer-reviewed articles related to the citizen science associations, this section is included here because these associations are producing epistemic impacts in both policy and scientific knowledge production systems. Therefore, their orientations to citizen science are epistemically significant in the context of this review. These organisations operate at macro scales, acting to convene fields of practice. They mediate with both knowledge production and policy institutions on behalf of their memberships (citizen science projects and the organisations they are located within), as well as negotiating enabling mechanisms within broader social structures.

Currently, four regional associations for citizen science have been established (in addition to numerous national associations), including:

- Australian Citizen Science Association (ACSA)
- Citizen Science Association (CSA) (*Global, but initiated and housed in USA*)
- CitizenScienceAsia (CSAsia)
- European Citizen Science Association (ECSA)

ACSA⁹², CSA and ECSA mainly foreground citizen science as the collaborative production of scientific knowledge, aligning with hegemonic systems of knowledge production, which include foci on community-based approaches to citizen science, but have no clear working groups or special

⁹² These insights were gained through a review of the homepages, 'about us' pages, and pages on ethics, working groups, collaboration, and values, on each of the association websites.

projects focused on post-abyssal or decolonial forms of knowledge production. All three organisations have dedicated working groups and foci regarding ethical research, inclusivity, diversity, and openness in data and metadata. CSAsia, as the newest of the regional associations, is not yet well established, with only a Facebook page with minimum information, the association seems to be primarily comprised of citizen science projects in Hong Kong currently. In their paper, Storksdieck *et al.*⁹³ (2016) describe a primarily hegemonic approach to knowledge production and systems of knowledge translation which centralises the production of scientific knowledges and methodologies. The authors describe the global collaborative work between the associations as enriching a global cross-disciplinary endeavour

that cherishes all forms of scientific research, science learning, and engagement aligned with the concept of citizen science (*ibid*:9).

Each of the associations forward collaborative approaches to field development, and focus on generating and supporting convening mechanisms and structures, including engagement with policy structures, and global representation of regional practices. Storksdieck *et al.* (*ibid*), who are representatives of ACSA, CSA and ECSA, describe the roles of such associations as supporting a shared understanding of evidence-based practices, successes, challenges, opportunities, and emerging practice standards. They outline a range of meditational roles that such associations are able to play.

5.4.3. A Dedicated Journal for Citizen Science

In 2014, representatives from ACSA, CSA and ECSA drafted a Memorandum of Understanding articulating three areas of global collaboration including, a) scholarship via the Citizen Science Theory and Practice Journal, b) ongoing joint conferences, and c) the development and sharing of online resources facilitating networking and sharing of best practices (*ibid*).

The launch of the *Citizen Science Theory and Practice* journal (CSTP) by CSA in 2014 created a centralised peer-reviewed focus for the articulation of theory and practice about citizen science. As an open⁹⁴, multi-disciplinary journal with a focus on scholarship about the practices of citizen science (rather than reporting on synthesised scientific findings arising from citizen science, as is

⁹³ Storksdieck, M., Shirk, J., Cappadonna, J., Domroese, M., Göbel, C., Haklay, M., Miller-Rushing, A., Roetman, P., Sbrocchi, C. and Vohland, K.

⁹⁴ The journal maintains a Creative Commons license which enables re-publication.

most common in other discipline-specific journals), the journal is intended to convene scholarship about and advance the field of citizen science more broadly.

The journal focuses on advancing the global field of citizen science by providing a venue for citizen science researchers and practitioners to share best practices in conceiving, developing, implementing, evaluating, and sustaining projects that facilitate public participation in scientific endeavours in any discipline. Authors include scientists, educators, community organizers, information technologists, conservation biologists, evaluators, land-use planners, and more (CSTP home page, 2021).

The journal currently includes two special issues on policy perspectives and ethics in citizen science, as well as publication categories focusing on review and synthesis papers, case studies, methodology and research papers, essays and meeting reports, and includes open discussion forums through which the wider community of practice might comment on and engage with published pieces. A review of papers published since the journal's inception indicate a range of disciplinary contributions, discussions on ethics, engagement with policy, and methodologies. There are also a number of counter-cultural or post-abyssal papers engaging with issues of epistemic, contributory and distributive justices.

5.5. Typologies of Citizen Science

There are a range of typologies describing types of citizen science projects available in the peer-reviewed literature. This section provides a brief overview of some of these ways of categorising citizen science projects, including Clark and Illman's (2001) categorisation based on activity type, Wilderman *et al.*⁹⁵s (2007) differentiation of community-based citizen science approaches, Bonney *et al.*'s⁹⁶ (2009a) typology based on forms of participation, Wiggins and Cowston's (2011) typology based on project purposes, the relational typology development by Freitag (2016), Schäfer and Kieslinger's (2016) permeable typology focusing on loci of knowledge production and project activities, and Dillon *et al.* (2016) heuristic differentiating between citizen science projects based on whether they respond to simple, complex and wicked social-ecological risks. Epistemic purposes and relationships seem to be the primary way of distinguishing projects from each other across each of these typologies.

One of the earliest typologies was produced by **Clark and Illman (2001)**. Clark and Illman (*ibid*) distinguish between a range of civic and citizen science systems based on the forms of activity

95 Wilderman, C. C., McEver, C., Bonney, R., & Dickinson, J.

96 Bonney, R., Ballard, H., Jordan, R., McCallie, E., Phillips, T., Shirk, J., & Wilderman, C. C.

engaged in. Their focus is on epistemic relationships. Their categorisation includes five groupings of activity:

- a) Civic science and civic scientists, which broadly describes a range of interactions between scientists and diverse publics;
- b) Citizen science and citizen scientists, which outline a group of interactions where various publics become more directly involved in generating scientific data of various forms of particular relevance to society, and/or evaluating scientific propositions which impact on society;
- c) Citizen volunteers, where the role of the public is to collect specific information, which contribute to professional science and to research which is generated and directed by professional scientists;
- d) Civic activism and civic activists, also referred to as people's science or popular science, where members of the public gather scientific and other forms of information, and play key roles in mobilising and directing research efforts; and
- e) Scientific activism and scientific activists, resonating with civic activism, but in this case arising from the mobilisation of scientists engaged in similar advocacy-related activities and emphasising the generation of 'science for the people'.

Their categorisation focuses on the particular form of relation between who is producing scientific knowledge, and to what end, and recognises that knowledge can be produced and mobilised towards diverse ends depending on why it is being produced.

Wilderman et al. (2007), on the other hand focus on the distinction between different models of community-based citizen science, based on five core criteria:

- a) Who defines the problem and sets the research agenda;
- b) Who designs the research study or investigation;
- c) Who collects data (e.g. samples);
- d) Who analyses the data; and
- e) Who interprets the data.

Based on these criteria, she identifies three models of citizen science within citizen science projects that can be labeled community science:

- 1) **Community consulting model**, where communities define the problem to be researched, and bring in consulting professional scientists to conduct research. She describes this as 'science for the people'.
- 2) **Community worker model**, where professional scientists define the problem, design the study and do the analysis interpretation work. The role of communities is limited to data collection (which

might include selective sampling or a basic level of analysis related to sampling (eg. counting eggs, or identifying markings, etc.); and the

- 3) ***Community-based participatory model***, where communities are involved in all levels and phases of the research.

Of particular interest is her observation of who uses the data, and towards which forms of action. She notes that data arising from the community worker model, in particular, gets taken up and used by scientists, and generally has a shelf-life constrained by funding models and study periods;

on the other hand, the community-based participatory model tends to result in a slower research process and uptake by community members which use it for a range of localised actions - the research is used to stimulate action based on what concerns the community directly, or in terms of what the community values, and continues to do so long after the study is concluded. "They can take the data and do something with it" (ibid, 2007:12).

[I]n terms of democracy, with the Consulting or Community Workers Model only experts can use the data. The volunteers are very dependent on them. With the Community-based Participatory Research Model, volunteers can shape the interpretations based on their own knowledge and can use the data, and I really feel it levels the playing field in terms of decision-making. (Wilderman *et al.*, 2007:14).

Wilderman *et al.*'s categorisation brings to the fore the epistemic roles and statuses of different epistemic subjects, and relates this to how knowledge is generated and mobilised in response to social-ecological risk.

One of the most often referenced typologies is **Bonney *et al.*'s typology (2009a)**. This typology is based on the varying degrees of control that citizen scientists have over different steps of the research process. Their typology is specifically in relation to public participation in scientific research in the context of informal science education, but has been leveraged outside of this focus in multiple ways. Bonney *et al.* distinguish between three main categories of projects:

- *Contributory projects*, which are typically designed by scientists, and for which citizen scientists primarily contribute data;
- *Collaborative projects*, generally designed by scientists, and for which citizen scientists contribute data and also help to refine project design, analyse data, or disseminate findings; and
- *Co-created projects*, which are designed by both scientists and citizen scientists working together, and for which at least some citizen scientists are actively involved in most or all steps of scientific knowledge production.

In 2011, **Wiggins and Crowston** offered a classification of citizen science projects based on the epistemic goals driving a project (epistemic purpose), or by topic being investigated. Their typology is

amongst the most analytically comprehensive of those reviewed, including 80 comparative features across projects, with a focus on North American projects. In this typology, citizen scientists are differentiated from other types of public participation in scientific research by the ‘active’ engagement of citizen scientists in scientific work, rather than passive forms of engagement. In their conclusion, the authors relate citizen science as, "a new type of open movement, welcoming contributions to scientific research from a diverse population of volunteers ..." and describe their goal for generating the typology as providing a "... comprehensive description of the landscape of citizen science to identify necessary conditions for successful research projects employing this mode of production", (*ibid*, 2011:9). Five categories of projects are identified, with the primary self-stated purpose of a project determining its categorisation. An overview of the five categories is tabulated in Table 6:

Table 6: Wiggins and Crowston's (2011) typology of citizen science based on purpose

Project categorisation by goals	Features and characteristics	Epistemic relationships
Action Projects	Volunteer-initiated projects adopting an action research model of activity which is mobilised in response to a local level of risk. Science is used as a tool to support what are described as ‘civic agendas’, and often involve longterm engagement with local risks and issues.	Organisational structure is grassroots or bottom-up, with scientists in a consultative or advisory role. Interestingly, authors point out that, <i>Their goals sometimes demand rigorous research procedures that require more substantial training and ongoing participation than many other citizen science projects, (ibid, 2011:5).</i>
Conservation Projects	Respond to natural resource management issues and goals, and involve citizens in stewardship practices. They are strongly rooted in place. Volunteer engagement is focused on data collection activities, and projects often include education and outreach goals as additional priorities.	Most often led by either academics or State-employed researchers. Projects are characterised by both top-down researcher initiated, and/or middle-out management initiated forms of organisation.
Investigation Projects	Focused on scientific research which requires data collection in physical settings. The primary interest is in building robust and legitimated formal scientific knowledges. Often includes secondary educational or training goals.	Such projects are most often organised by academics or non-profit conservation organisations, and have a top-down organisational structure with a large number of volunteers.

Project categorisation by goals	Features and characteristics	Epistemic relationships
Virtual Projects	Like investigation projects, the main goal within virtual projects is the production of legitimated scientific knowledges, where investigation into a physical setting is not required. Virtual projects are entirely ICT-mediated, and require a critical mass of contributors to produce viable data.	They employ top-down organisational structures, and often have tiered memberships.
Education Projects	Prioritise outreach and education goals, and can be subdivided into those focusing on formal vs informal learning opportunities. They include relevant aspects of place.	Employ top-down organisational structures, and generally involve multiple different types of organisational partners.

Wiggins and Crowston (2011) offer some articulation of knowledge production in relation to ‘matters of concern’, but only implicitly, through project descriptions. Foregrounded are ‘matters of fact’, and the ways in which projects work towards, or defer to the production of ‘matters of fact’. As a result, the purpose of volunteer contributions, according to the authors, is to support the production of scientific knowledges into the scientific community.

The clear exception of this is in the Action category, whose projects respond to contextual risk, but are less concerned with the production of scientific knowledges only. The authors do, however, explicitly recognise different roles and power structures within the different purpose categories.

In addition, although the paper often foregrounds more traditional hegemonic, scientific processes of knowledge production, the authors also demonstrate a recognition of especially epistemic purposes, scales, recognitions, and ways of producing [scientific] knowledges which provide openings for the consideration of a wider scope of epistemic purposes and knowledges beyond modernist sciences. They categorise applied resource management knowledges, and action-oriented knowledges especially, within their typology.

Another often referenced typology was developed by **Freitag (2016)**. This typology characterises relationships between citizen scientists and management agencies along two planes - cooperative/adversarial, and deliberate/serendipitous. The typology aimed to facilitate a stronger understanding of preferred, as well as more sustained approaches to collaboration. One of the key features of Freitag’s

form of typographical representation is the use of planes, rather than discrete categories, in order to account for variations and movement during project lifespans.

Citizen science is framed as a balancing of many priorities, including education, environmental stewardship, research and social justice. Freitag also notes that the community involved in a particular initiative varies depending on how they communicate, and their ties to a specific geographic location (ibid). She concludes the paper by highlighting the different forms of epistemic objects and relationships required to enact each approach in the typology. She also notes the expansive tendency of projects towards more cooperative approaches over time (ibid).

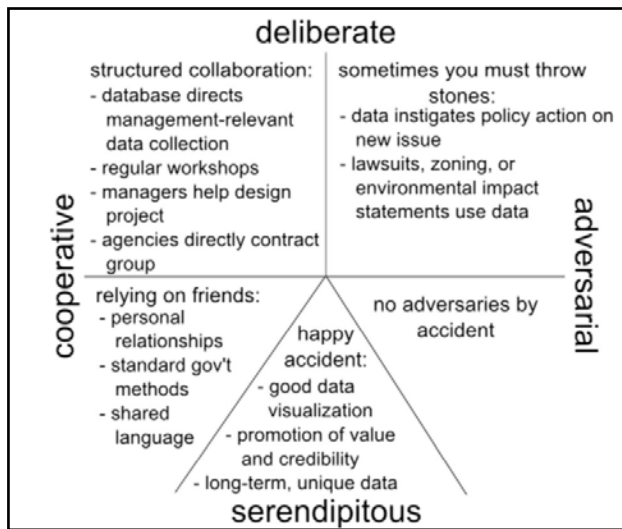


Figure 19: Freitag's typology of citizen science characteristics in the context of citizen science and adaptive management (Source: Freitag, 2016:519).

Schäfer and Kieslinger, (2016), in their paper motivating for the acknowledgement and recognition of a broad diversity of citizen science approaches, argue that typologies with fixed categories are too narrow and limited to accurately reflect both the diversity of projects, and the permeable and mobile nature of various approaches. Instead, they choose to articulate a matrix with two axis, a) knowledge producers, and b) project foci (*ibid*). Their primary interest in developing the matrix is to create a versatile and fluid representation of projects, with particular interest in 1) the locus of knowledge creation, which describes a range of knowledge creation roles between citizens and scientists, and 2) the focus of project activities, including a continuum between research-driven projects which aim to answer scientific questions, to projects whose primary aim is intervention into social-ecological systems (*ibid*).

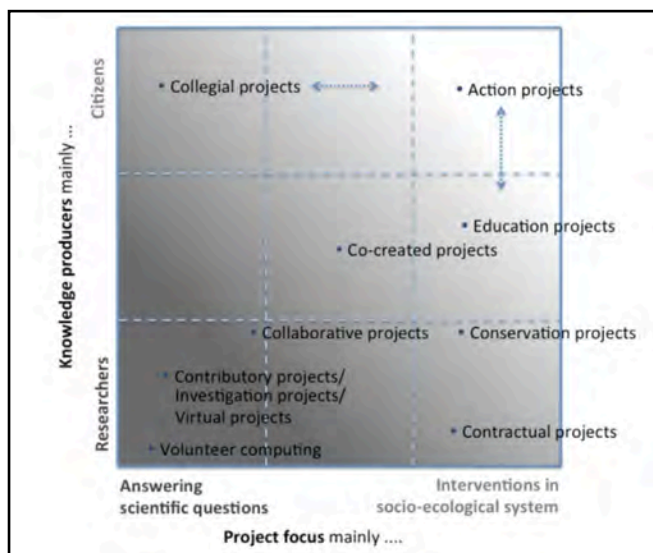


Figure 20: Schäfer & Kieslinger's matrix of citizen science approaches. Source: Schäfer & Kieslinger, (2016:3).

Dillon et al. (2016) take as their starting point, the type of social-ecological risk being responded to. They categorise citizen science approaches based on whether they are responding to simple, complex or wicked problems. They consider two intersecting variables: possibilities for forms of participation in diverse activities, and possibilities for autonomy and goal-setting. Dillon et al. suggest that it is important to reflect on the type of problem you wish to respond to, before designing a citizen science project (*ibid*). The authors contend that both the types of participation and the types of science being engaged in response to social-ecological risks require a paradigm shift so that they are better able to respond to complex and wicked social-ecological risks. This typology, once again, focuses on epistemic roles and statuses of diverse epistemic subjects, and their the relationships to types of risk.

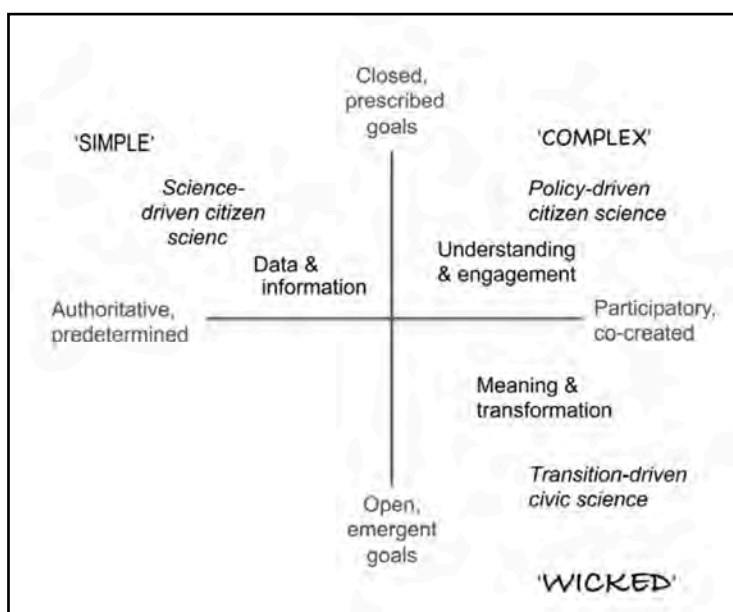


Figure 21: Dillion et al.'s heuristic of citizen science. Source: Dillion et al. (2016:452).

Expanding on the above, Eitzel et al. (2017) provide a powerful disruption of a range of typologies for citizen science. Their paper provides a strong onto-political engagement with the terminology used to describe various modes of citizen science, and the dangers of applying such conceptualisations to all articulations of citizen science. Together, the co-authors from diverse fields of citizen science practice and geographical locations problematise conceptions of citizen scientists and 'professional scientists', epistemic roles and statuses, forms of knowledge production, reasons for knowledge production, and the ways of categorising and describing the knowledge cultures of citizen science projects. They argue for the importance of balancing coherent shared practices with a plurality of terminology, recognising that terminology has ontological weight, and epistemic and axiological implications (ibid). They include both scientific and other forms of knowledge in the critique, engaging a strongly post-abyssal expansion to thinking about typologies of citizen science.

The authors of each of these typologies highlight the significance of epistemic roles and statuses, and how these impact on the types of knowledge being produced, and the ways in which such epistemic arrangements allow knowledge to be mobilised in response to diverse social-ecological risks. Evident in each typology are the ontological politics which underpin notions of knowledge, knowledge production, knowers, how and why knowledge objects can be used, and how knowledge should and could be mobilised. Clark and Illman (2001), Wilderman et al. (2007), Bonney et al., (2009a), Wiggins and Crowston (2011), and Freitag (2016) provide typologies which take as their ontological basis, the hegemonic knowledge cultures of scientific knowledge production. They encompass a range of traditional epistemic roles which are constituted within more normative scientific knowledge practices, with the exception of projects that arise from within communities themselves. On the other hand, Schäfer and Kieslinger disrupt hegemonic notions of epistemic roles and statuses, and speak to stronger forms of epistemic, contributory and distributive justices. Dillon et al. (2016) reorient our ways of categorising the epistemic cultures of citizen science projects so that we begin by considering the complexity of the social-ecological challenge being faced; their typology resonates in some ways with Latour's distinctions between 'matters of fact' and 'matters of concern', where the production of simplified knowledge is inappropriate for addressing complex or wicked risk. As Eitzel et al. (2017) point out, how we name and conceptualise epistemic relations reinforces the ontological and axiological arrangements such concepts arise from.

5.6. Foregrounding Knowledge Production in Applied Contexts

In addition to literature focusing on broader aspects of citizen science theory and practice, there are also a range of more discrete disciplinary groupings focusing on knowledge production and application within specific areas of knowledge production and application. Below is a brief insight into how these clusters of activity articulate their epistemic practices. Publications are too numerous to present a detailed report here. Instead, I have highlighted three regions of epistemic engagement as illustrative examples - a) Conservation, ecology and applied resource management, b) learning-oriented citizen science, and c) counter-cultural and post-abysal publications. My focus is on epistemic arrangements, with a particular interest in how, and which, knowledges are reported. The first two regions of epistemic engagement lend insight into two of the most often referenced outcomes of citizen science processes of knowledge production, and the third reviews types of counter-narratives in the field.

5.6.1. Conservation and Applied Resource Management

Overview papers: Ellwood, Crimmins and Miller-Rushing (2017) provide an overview to a special addition to citizen science and conservation, in the Journal of Biological Conservation, (a number of the papers in the special addition were reviewed, and are commented on below). The paper provides a positive argument in favour of the integration of citizen science for conservation. The paper begins with an economic and productivities rationality for why citizen science is a useful approach to knowledge production towards conservation goals (*ibid*). The authors note that,

Citizen science can expand research capacity while providing stimulating opportunities for participants, engaging volunteers directly in conservation science and management, and improving science and environmental literacy. Citizen science has already made tremendous contributions to conservation science, and this approach of leveraging the power of volunteered data, information and skills has the potential to do much more (*ibid*:1).

The overview centers two concerns, a) how to improve data contributions and integrity, and b) a discussion about how participation can lead to learning or changes in behaviour (including an interest in agency and action), (*ibid*). Learning is primarily framed as a) behaviour change, rather than other forms of learning, or b) as the development of scientific literacy which directly translates to conservation action (although the authors do also consider mechanisms to stimulate and more deeply support self-directed conservation actions) (*ibid*). Knowledge is framed solely as scientific knowledges through scientific systems of productivity, with professional scientists directing and mediating key epistemic activities.

In their well cited paper on the state of citizen science as a tool for ecological research and public engagement, Dickinson *et al.* (2012), argue for citizen science as a public good that is generated through collaborative tools and resources, while also supporting public participation in science and stewardship (*ibid*). The authors adopt Bonney's definition of citizen science (with Bonney as one of the paper authors). Democracy is equated with opening up participation to contribute data to larger groups of people, and knowledge production and translation systems are framed hegemonically. Systems of knowledge production and legitimation are confined to scientific systems, and descriptions of educational approaches are geared towards increasing volunteer ability to contribute accurate and legitimate data to professionally designed research.

Illustrating a range of assumptions about learning, the authors suggest that,

[f]or large-scale projects, learning is probably the greatest during data collection, as participants begin to develop questions based on their field observations. Learning may also happen when participants interact with data through dynamic graphing and mapping tools (*ibid*:295).

The authors also acknowledge more community-centric approaches which enable citizens to generate data about issues that concern them, although this argument remains superficial and contentious in a number of assumptions. For example, the authors argue that regardless of whether projects are,

contributory, collaborative, or co-created, ecologically based citizen-science projects are a natural fit for scientific endeavors with important environmental or public-policy implications because they engage the affected populations from the start (*ibid*: 292).

and that,

benefits to professionals and participants overlap because learning, data, and results constitute a fully sharable public good (*ibid*:292).

The above perspective implies modernist hegemonic framings of participation and democracy if defined from a post-abyssal perspective, as well as raising questions of what counts as legitimate participation in the contexts described. The authors note that their arguments are based on the assumption that participation in scientific research (most often as data contributors), creates authentic learning experiences (*ibid*). Overall, the paper primarily focuses on hobbyist and naturalist forms of ecological research, which is 'fun and exciting' for volunteers, excluding risk-based interactions and approaches.

Miller-Rushing, Primack and Bonney (2012) also provide a historical (and hegemonic) account of public participation in ecological research which foreground historical instances of data collections contributing to scientific research by citizens. The article is interesting in that it frames citizen science as either an approach through which citizens contribute to the research of professional scientists, or which citizens do because scientists are unwilling to do so (due to locality, scale, or area of research), (*ibid*). The latter category may, the authors note, lead to policy or management solutions, once citizens

have discovered causes (*ibid*). Knowledge is framed hegemonically, once again, with science being the only form of acknowledged knowledge, and knowledge translation falling solely to scientists and policy or management professionals.

Data generation and applied conservation: Cooper *et al.*⁹⁷ (2007) discuss citizen science as a tool for conservation in residential ecosystems. Their paper defines a clearly dualistic ontology which maintains society and nature as distinct from each other, with humans impacting on nature in ways which require management. Unsurprisingly, with Rick Bonney as one of the authors, the paper forwards a notion of citizen science as a tool for scientific data collection and public outreach, with citizen scientists being positioned as both contributors to scientific knowledge production through data collection, and as potential stewards of residential ecosystems (*ibid*). While the authors reference field-based arguments for stronger participatory democracy, and the inclusion of socio-political factors in decision-making - decision-making that communities are included in, their primary aim seems to be to promote the application scientist-led models of citizen science into a new field of practice. For example, the authors build on the premise that,

Most citizen science projects have an underlying, testable assumption that engagement of the public in the process of research has scientific, educational, attitudinal, and behavioral outcomes. If this is the case, then an adaptive management model of citizen science for residential lands will involve changes both in the management prescription and the knowledge, attitudes, and behavior of participants (including members of the coordinating organization) as they move together toward an optimal management strategy (*ibid*:5).

[and that] the outcomes evaluated are complex and include the research, management, and conservation impacts, as well as the human impacts measured as conservation literacy, public support for residential ecosystem management, and increases in other, seemingly unrelated conservation-based behaviors, such as behaviors that reduce an individual's carbon or ecological footprint (*ibid*:5)

Notions of participatory adaptive management here, are about increasing citizen participation in established systems of knowledge production and biodiversity management in ways which help citizens to become scientifically literate so that they are better able to adhere to management strategies which require them to change their behaviours. Learning is framed as a form of scientific literacy which enables citizens to change behaviours in the context of scientific findings about their environmental impacts, based on data collection through pre-defined biodiversity monitoring tools.

For similar arguments, see Devictor, Whittaker and Beltrame (2010), who offered one of the earliest arguments promoting citizen science for generating large amounts of biodiversity data for conservation, as well as providing a simultaneous avenue for science outreach. Hochachka *et al.*⁹⁸ (2012) argue for the benefits of data-intensive citizen science based on economic rationalities

97 Cooper, C. B., Dickinson, J., Phillips, T., & Bonney, R.

98 Hochachka, W. M., Fink, D., Hutchinson, R. A., Sheldon, D., Wong, W. K., & Kelling, S.

(decreased cost of research), and the benefits of user identification, which is currently more accurate than digital systems. Authors focus on increasing scientific legitimacy of data through a range of scientific protocols and analysis methods (all engaged by professionals). Dickinson, Zuckerberg and Bonter (2010) in their review of challenges and benefits of citizen science towards ecological monitoring, define citizen science as public participation in scientific thinking and data collection. Benefits recognised are economical, geographical scale, access to private land, long time-series data, and challenges focus on data quality, application of data protocols, data cleaning, and analysing processes. Benefits and challenges are articulated only in terms of scientific knowledge production, which is then translated into applied conservation. Learning is conflated with training, and training is geared towards identification skills and accuracy, and improving protocol implementation.

Open data: Sullivan *et al.*⁹⁹ (2017) argue for the benefits of open access observational data generated by citizen scientists, focusing on clear scientific protocol design and careful consideration of formats for open database generation and production. Their arguments are primarily of a technical nature, with a focus on data mobility and potential for application (*ibid*). Their account refers to citizen scientists only as the providers of data, whose contributions should be managed in diverse ways to ensure usability. Hegemonic notions of the relationships between data and intervention into a range of applied contexts are thoughtfully outlined, but maintain simplistic notions of knowledge translation based on scientific data alone. For example they note that,

widespread use of data by private individuals suggests that this data set is useful to the layperson, perhaps overcoming the often-cited knowledge to action barrier (*ibid*:10).

No other forms of knowing are considered in the application of data into context.

Citizens' learning through data contribution: Forrester *et al.*¹⁰⁰ (2017) reflect on citizen scientists' informal learning within the eMammal platform. Notions of citizen science are based on Bonney's (1996) conceptions of contribution to scientific research, and informal ecological learning (Forrester *et al.*, 2017). Once again, learning is framed as volunteers ability to contribute with greater accuracy to data collection protocols, as well as whether volunteers shared what they learnt with others, and experienced a behavioural shift in relation to conservation efforts (*ibid*). Using survey methods and expert verification of volunteer identifications of species, the authors found that volunteers showed little or no improvement in identification skills, or conservation attitudes through project participation, although there was evidence of rapid improvement of skills development in terms of laying camera traps (*ibid*). Epistemic activity was described in terms of scientific knowledge production (the stated

99 Sullivan, B.L., Phillips, T., Dayer, A.A., Wood, C.L., Farnsworth, A., Iliff, M.J., Davies, I.J., Wiggins, A., Fink, D., Hochachka, W.M. and Rodewald, A.D.

100 Forrester, T. D., Baker, M., Costello, R., Kays, R., Parsons, A. W., & McShea, W. J.

goal of the project), and learning was informal in nature, and geared towards facilitating the development of scientific competencies. No other forms of knowledge are recognised in the paper. Lewandowski and Oberhauser (2017) make a related argument about increasing citizen scientists' engagement in conservation through butterfly monitoring.

McKinley *et al.*¹⁰¹ (2017) extend data contribution, learning and outreach arguments to include application of knowledge gained through data contribution and knowledge gained through science learning, towards involvement in conservation, management and policy discussions and decisions. This, they suggest, might be done through sharing information with wider communities and moving others to get involved in conservation, etc. (*ibid*). Public input into policy and management systems is delineated via formal channels of State systems, foregrounding institutionalised systems of deliberative democracy (and thereby excluding participatory or radical democracy, see 3.3.1), and are directly related to what they learnt about conservation and resource management through project participation (*ibid*). However, authors also suggest that citizen scientists might also help conservation scientists, natural resource managers, and environmental organisations to better understand public priorities and social contexts, thereby enriching public dialogues (*ibid*). While openings towards a more expansive process are provided, a hegemony of knowers and knowledges is maintained, with citizens being able to express their local priorities, and largely mirroring the professionally-mediated scientific knowledges gained through project participation. Knowledge legitimisation is largely maintained as a scientific activity.

Significance of place: more expansively, Newman *et al.*¹⁰², (2017) consider the power of place for effective conservation decision making. The basis of their argument is that leveraging 'the power of place' in citizen science, improves conservation decision making, increases participation, and improves community resilience (*ibid*). The basis of decision making is legitimated scientific knowledge which arises from, and is applied to place or context. The authors also define place as including material and symbolic perspectives, embodied experiences, emotions, culture and interconnections (*ibid*).

They recognise the significance of local knowledges in relation to place, and the active dynamic of place-making, and the iterative relationship of being made by place (ibid).

This is reconciled through an approach of analytical dualism, where aspects or elements are recognised as both distinct and interconnected. As part of their toolkit, they include a recognition of

101 McKinley, D.C., Miller-Rushing, A.J., Ballard, H.L., Bonney, R., Brown, H., Cook-Patton, S.C., Evans, D.M., French, R.A., Parrish, J.K., Phillips, T.B. and Ryan, S.F.

102 Newman, G., Chandler, M., Clyde, M., McGreavy, B., Haklay, M., Ballard, H., Gray, S., Scarpino, R., Hauptfeld, R., Mellor, D. and Gallo, J.

diverse knowledges (local, traditional, scientific or arts-based), as well as situated, intuitive and relational knowledges. They also articulate overlapping ontologies within the same place, as constituted through the diverse relations that people have with a place (*ibid*). They point out that,

the names we ascribe, the multiple forms of knowledge that influence our understanding of place can have a dramatic impact on our activities in relation to place. Science produces one form of empirical knowledge, and can be compared with Traditional Ecological Knowledge (TEK) as a related yet also distinct way of knowing a place. ... our epistemologies (e.g. our claims about how we produce knowledge about a place) shape our activities within a place (*ibid*: 57).

Newman *et al.* suggest that leveraging the ‘power of place’ in citizen science can engender stronger forms of collaboration in terms of co-identifying place-specific issues and needs (*ibid*). However, even with an expansive framing of knowledge, these knowledges are ultimately still reconciled to the production of scientific knowledges - albeit from a more strongly situated perspective (which contributes to the production of stronger science). Knowledge production in this approach remains largely hegemonically framed in that it privileged modernist scientific processes of knowledge production and legitimation, while also enabling a greater capacity for participation in science-mediated forms of participatory democracy and conservation action. Also see Haywood, Parrish and Dolliver (2016) for a related argument about place-based and data-rich citizen science and its relationship to conservation action, and Loss, Loss, Will and Marra (2015) within large-scale bird conservation, who argue for place-based approaches to citizen science which are scientifically designed to increase their conservation efficacy. Jordan *et al.*¹⁰³, (2016) extend these arguments through the addition of learning feedbacks and adaptive management strategies; their arguments include discussions of agency-building towards social-ecological change. Similar arguments for increasing participatory democracy and conservation efficacy include Gray *et al.*¹⁰⁴'s (2017) arguments for combining participatory modelling and citizen science to support conservation actions by volunteers.

Wisdom of the crowd and integration of local knowledges: Predavec *et al.*¹⁰⁵, (2016) provide one of the few accounts of more imaginative research methodologies.

They compare the ecological conclusions of species decline through professional scientific research, and citizen science lay knowledges. Instead of citizen scientists contributing data via pre-established scientific protocols to measure population decline (e.g. species locations and number counts), they were asked to answer what they thought the population trend for koala were, directly (ibid).

103 Jordan, R., Gray, S., Sorensen, A., Newman, G., Mellor, D., Newman, G., Hmelo-Silver, C., LaDeau, S., Biehler, D. and Crall, A.

104 Gray, S., Jordan, R., Crall, A., Newman, G., Hmelo-Silver, C., Huang, J., Novak, W., Mellor, D., Frensley, T., Prysby, M. and Singer, A.

105 Predavec, M., Lunney, D., Hope, B., Stalenberg, E., Shannon, I., Crowther, M. S., & Miller, I.

The authors found that lay knowledges about koala population trends corresponded well with other forms of scientific population data generated by professional scientists (*ibid*). Interestingly, authors found that a diversity of opinion yielded greater ‘crowd-based wisdom’, informed by a range of local knowledges (*ibid*). Although the authors integrated local knowledges, the study was still scientific in nature, with experts designing the study and analysing data, and rationalities underpinning the study remained hegemonic and biased in favour of scientific methods of knowledge production. Lay and local knowledges were a form of novel data, rather than actively engaged within an ecology of knowledges, towards the production of common knowledge.

Small scale conservation efforts and land trusts: Like many other authors in this cluster, Peters *et al.*¹⁰⁶ (2017) see citizen science as a way to cost-effectively collect data, engage in science and conservation outreach, building social capital, and increasing public support for land trust-based conservation (*ibid*). Knowledge is limited to scientific knowledge, which is translated into conservation application, with no other knowledge forms reported. What is distinct in this sphere of citizen science practice is that, due to the small and poorly funded and small-scale organisational nature of land trusts, they rely on volunteers to collect monitoring data, assist in analysis of data, as well as implement management decisions arising from analysis (*ibid*). Volunteers also form an important aspect of land advocacy and awareness-raising initiatives as well (*ibid*). Authors note that fostering collaborative participation in order to promote new forms of learning can result in an increase in conservation values (*ibid*).

Overwhelmingly, based on the 65 resources reviewed in this chapter, narratives about citizen science and conservation are dominated by hegemonic notions of knowledge production and translation, where the primary contribution of citizen scientists is framed as the production of scientific knowledge, and the implementation of scientist-generated findings into applied contexts. Any discourses about other knowledges are ultimately focused on strengthening data contributions, increasing motivation, and supporting science and outreach programmes geared towards community behaviour change. Across the range of papers, authors also recognised the value of engaging citizen scientists in this form of knowledge production, recognising the many applied conservation impacts that citizen science generated data have yielded. Based on the specific cases sited, it seems unarguable that citizen science contributions to the hegemonic systems of knowledge production are valuable, economical, and increase the potential for particular forms of scientific research. Also clear is that there is little engagement with issues of

106 Peters, C. B., Zhan, Y., Schwartz, M. W., Godoy, L., & Ballard, H. L.

epistemic, contributory and distributive justices (see 1.3.1), nor conceptions of participatory and radical democracies (see 3.3.1) which are not mediated through or translated by professional scientists.

5.6.2. Citizen Science and Science Education

As argued in 1.2.1. and 1.2.8, learning and educational aspects of citizen science projects are generally weakly researched and articulated, with many assumptions about how learning occurs being forwarded. At the same time, learning and scientific literacy development are often referenced as reciprocal benefits of citizen participation in projects. Below is a brief review of literature discussing learning and citizen science.

Citizen science and informal science learning: In one of the most referenced texts, Bonney *et al.* (2009a) outline public participation in scientific research, with a focus on informal learning. The paper reports on an analysis of informal science learning in ten citizen science projects, using a typology of citizen science including three categories - contributory, collaborative and co-created project models (*ibid*; see 5.5. for details).

At the core of most projects is a scientific question or environmental issue that is best addressed by analyzing large amounts of data that are collected across a wide area, or over a long period of time, or both (*ibid*:15).

Although the authors sometimes refer to more active approaches to learning, their primary representation of learning appears to be dominantly behaviourist¹⁰⁷, with assumptions that participation in science-related activities (even if confined to data collection), lead to understanding of complex ecological systems and social-ecological risks, while also enabling agency for local actions. The limited framing of learning and agency-development is reflected in their assertion that,

many PPSR [public participation in scientific research] projects were started with an emphasis on scientific or community problem-solving goals as opposed to educational goals. In other words, we are layering educational models over projects that were developed not so much to help people learn about science as to address scientific or community needs (*ibid*: 20).

The authors highlight that collaborative and co-created models are more likely to enable such forms of learning, but also take pains to defend contributory models as fertile opportunities for informal learning. In addition, their analytical rubric lacks analytical categories for learning outcomes beyond science investigative skills, attitude and behaviour change, although they broadly claim learning outcomes well beyond the scope of their analysis.

¹⁰⁷ Behaviourist approaches to learning focus on positive reinforcement and conditioning to shift or change behavioural patterns in learners. See critiques leveraged by Woznaik (1993) and Quicke (1975).

Their conceptions of learning are offered as a way to analyse public participation in scientific research across all forms of projects, but their conceptions of who the public are appear to primarily recognise hobbyists and naturalists as participants in citizen science (people collaborating for fun and to engage in activities that interest them recreationally); they exclude, for example, those advocating for rights or engaging in risks impacting their wellbeing directly or those challenging hegemonic scientific structures. In other words, the focus is on projects working towards general knowledge production and generic risks, which are mediated by professionals, rather than specific manifest risks with immediate impacts, or approaches that challenge the knowledges produced by professionals. This reflects a tendency in many accounts of citizen science, which recognise community-based approaches to citizen science, but seem unsure of how to deal with them. Such projects are often categorised in a single group, and referenced in passing, but never more fully analysed or considered for counter-cultural and more expansive approaches to knowledge production and learning. Bearing in mind the limited nature of their framing of learning, Bonney *et al.* (2009a) found that projects,

categorized as Collaborative or Co-created, yield the greatest impacts in terms of understanding science process, developing skills of scientific investigation, and changing participants' behaviors toward science and/or the environment. Indeed, it stands to reason that people who have participated intensively in a research or monitoring project will be that much better consumers of science, will be more active in decision making around science and the environment in their communities, and will change their behavior toward the scientific problem being investigated more substantially, than individuals who are involved peripherally in a project (*ibid*:48)

Overall, the paper focuses on a particular relationship between science and its publics - one in which publics must develop the scientific literacy necessary to collaborate with professional scientists, State institutions and resource managers. The aim of science learning is to support citizens to take up this role so that they might more efficiently, enthusiastically, and collaboratively, work with institutionalised knowledge structures, and so that they may become facilitators of science in their communities. The paper excludes mention of other forms of knowing, or other types of knowledge roles.

Scientific literacy or content knowledge development? Trumbull *et al.* (2000) and Trumbull, Bonney and Grudens-Schuck, (2005) provide reviews of citizen science projects which focus on science education curricula which were designed to promote science-inquiry learning. Each indicate that while participating learners did not necessarily increase scientific literacy, they did promote an increased science content knowledge. Nor were educational activities significantly impactful in increasing volunteer motivation - the volunteers were already largely self-motivated to participate because of a desire to make a worthwhile contribution to an area of conservation they cared about (Trumbull *et al.* 2000; Trumbull *et al.*, 2005). This raises ethical concerns about claims that citizen scientists receive learning opportunities to develop scientific literacy in exchange for time and resources; how is the

exchange for increased science content learning, which benefits primarily the scientists engaging in knowledge production, an enactment of distributary justice, as implied in many citizen science texts?

The following cluster of papers report on classroom-based pedagogic practice using citizen science. Shah and Martinez describe citizen science as, “a partnership between inexperienced volunteers and trained scientists engaging in research” (2016:17). They argue that the integration of citizen science into the science classroom provides a means for addressing deficiencies in a fragmented education system, providing opportunities for integrating practical experiences in scientific enquiry (*ibid*). They describe citizen science as a way to emphasise the recognition and use of systematic approaches to community problem solving, and provide an orientation to a methodology for integrating citizen science into classroom practice (*ibid*). Citizen science is conceived of as a way to strengthen scientific literacy and induct learners into hegemonic systems of scientific knowledge production. Similarly, Cardamone and Lobel (2016) outline a procedure for integrating citizen science approaches to learning into classrooms as a way to support scientific literacy development in under-represented minority groups of learners, increase engagement of science majors, and provide unique hands-on opportunities for science learning. Here, citizen science related learning is framed as a way to increase retention in science, technology, engineering, and mathematics (STEM) fields (*ibid*). Their arguments focus on increasing epistemic access to the sciences and science-related fields of study. Portas *et al.*¹⁰⁸ (2016) offer an account of science outreach through the National Eclipse Weather Experiment, with a focus on self-identification with the role of scientists and engagement with science, technology, engineering and mathematics subjects. The focus of learning is related to data collection and development of science content knowledge, and authors provide recommendations for implementation of similar projects with schools. Recommendations focus on usability of data collection protocols, collaboration with partner organisations who can facilitate contact and communication with schools, and gaining feedback post project to improve future activities.

Kridelbaugh (2016) extends these arguments to include non-major science students, providing a pedagogic guide for teachers wishing to use online citizen science to provide experiential learning opportunities (*ibid*), and Mckenney *et al.*¹⁰⁹ (2016) provide direction for engaging learners in soil science-related citizen science. Yoho and Vanmali (2016) offer a pedagogic approach for using citizen science to engage learners in controversial biological and environmental topics such as evolution and climate change. Here, controversy is mediated through the collection and analysis of data. Braschler (2009) recounts the success of an ant monitoring project in a resource poor context, as an approach to

108 Portas, A. M., Barnard, L., Scott, C., & Harrison, R. G.

109 McKenney, E., Flythe, T., Millis, C., Stalls, J., Urban, J. M., Dunn, R. R., & Stevens, J. L.

support authentic science learning, while concurrently collecting scientific data. Oberhauser and LeBuhn (2012) argue for the benefits of including undergraduate students in citizen science projects, including through data collection, as research opportunities, and as class projects. They argue for the benefits of this approach in enabling learners to engage in research learning that is ‘consistent with the nature of scientific inquiry (AAAS 1989)’ (*ibid*:318). Finally, Stockwell (2016) describes the use of citizen science for both scientific literacy development, and science communication, including analysing science and scientists within social contexts. The focus in Stockwell’s pedagogic approach is on communicating about science as a form of scientific literacy, rather than actual scientific experimentation (although experimentation is included in the activity sequence). In all of these papers, science learning is framed hegemonically and in terms of scientific literacy deficits, and exclude other forms of knowing. They are geared towards increasing epistemic access to modernist scientific fields of study.

Citizen Science and Democracy-Building:

Edwards (2014) notes that much attention has been given to the technicalities of implementing citizen science projects, focusing on data quality and validity, technologies, and attitudes to science. However,

*much less attention has been given to who the citizens are contributing to these scientific projects, the forms of knowledge and expertise they draw upon in making their contributions, the knowledge practices in which they engage, what they learn from participation and in what ways conceptually the latter are specifically ‘citizenship’ practices (*ibid*:276-377).*

*In a collective conversation about citizen science, schooling and science education, Mueller, Tippins and Bryan (2012), Barton (2012), Weinstein (2012), and Cooper (2012). Mueller et al. (2012) begin the conversation by proposing that citizen science is constrained in its current enactment in school-based science education. The authors foreground arguments for science education as authentic forms of participatory and radical democracies, with a focus on the ways that science becomes relevant to the lives and communities that youths are situated in (*ibid*). An important aspect of their argument is the evolution and expansion of the roles that teachers and educational overseers see as their own. Mueller et al. (2012) point out that, “citizen science has a much different meaning within science than in education”, and that within science education, there is often a,*

*simplistic assertion that scientific knowledge is best derived through standardized protocol (the scientific method) and that science serves as the only true authentic source of knowledge in our lives today. The scientific method does not suggest that investigators take into account ethical, political, and social studies but rather reinforce the assumptions of objectivity in our very ways of knowing (*ibid*: 3).*

The authors raise questions about conceptions of learning, and about what counts as legitimate knowledge within citizen science practices, challenging the hegemony of particular forms of

positivist science and a culture of scientism. They also highlight the challenge of participation for those citizens who wish to participate in ways that are of their own design (ibid). As an alternative to positivism and scientism, Mueller et al. argue for relational forms of knowledge which meaningfully and authentically integrate scientific, and diverse other forms of knowledges in ways which enable response to situated and manifest social-ecological risks (ibid). The authors challenge both the naturalisation of differences and the monoculture of knowledge, recognising that scientific knowledges themselves have emerged as a collective human project, out of a range of knowledge systems and cultures (ibid). In addition, they argue that knowledge contributions from peoples with a diversity of aspirations, norms, beliefs, and cultures are more likely to yield stronger degrees of confidence in knowledges being produced, and that the exclusion of some groups systematically erodes their diverse geographical knowledges (ibid).

The authors point out that,

[w]hereas citizen science gets its power from basking in the sun of science, there is much more to science that is often not acknowledged as part of the endeavor, such as cultural, ethical, political, and spiritual (and virtual) studies (ibid:5).

They also argue that school-based science (and monitoring approaches to citizen science, more broadly) fail to re-enact the forms of science that scientists themselves are working on, which include complex social-ecological systems and wicked problems, and offer scepticism about what citizen science data contributions actually achieve. They ask,

whether citizen science data are being collected to generate awareness around scientist-generated agenda. In other words, it may be the case that scientist-driven citizen science projects merely serve to create apparent panoptic crisis situations to help increase support for expert-research, when the general public does not understand that spatial and temporal scales play a role in the ways in which biological conditions are contextually embedded with sociocultural, historical, ethical, political, spiritual, and virtual spheres of influence for them (ibid:5).

The basis of their critique of citizen science approaches to data collection and claims about learning are that overly simplified scientific protocols, which forward the interests, understandings and concerns of the scientists who construct them, provide citizen scientists with an illusion that they are ‘doing something scientific’, when what they are contributing fails to capture the integrated nature of science, culture and consequence (ibid). Instead, for these authors, meaningful and authentic learning requires learners, their teachers, and their teacher support structures, to engage in and enact authentic, relational forms of knowledge production (ibid).

In contrast, Cooper’s (2012) response to Mueller et al. (2012) provides a more hegemonically aligned account of learning across a range of ‘public participation in scientific research (PPSR)’ approaches, arguing that all models of PPSR are advancing toward being a means for civic engagement by

empowering people to contribute to knowledge formation and values articulation. Her argument defends claims that data collection builds scientific literacy, and enables citizen scientists to advocate for their communities on the basis of such literacy. She also argues that values should remain distinct from reliable, repeatable and indisputable science, and like scientists, citizens should be able to argue for their values, but should maintain them as distinct from their contributions to PPSR (*ibid*). Cooper's arguments forward a dualistic ontology which maintains and elevates the hegemony of scientific rationalities.

Joining this conversation, Barton (2012) recognises two lessons to be learnt from the critiques offered by Mueller et al. (2012). The first lesson is that,

*[c]itizen science, as a tool, historically has not been about democratizing science —about offering multiple perspectives or transforming a knowledge base or set of tools or resources—but rather has been about getting more work done ... the emphasis is on “getting it right” rather than on figuring out what multiple perspectives might yield or how to “do science better” (*ibid*:2).*

*And the second regarding the philosophical bases of citizen science, opens questions about whom citizen science belongs to, recognising feminist concerns that science belongs to those who control it, and whom it benefits (*ibid*). Barton points out that there are few examples of science-education interaction, where local knowledges and practices are taken as fundamental dimensions of doing science, rather than being viewed as motivations for learning (*ibid*). She pushes Mueller et al's arguments (2012) by asking how intersections among relationships within communities and the sociocultural and geohistorical dimensions of place might further redirect citizen science (2012). Barton argues that, “doing science with, in, and for the community fundamentally involves a reconstruction of citizen science in ways that account for their sense of place”, (*ibid*:3). Ultimately, Barton is arguing for a more central role for local knowledges and situated experiences, in ways which might not align with science, but ultimately expand how youth come to know, and to teach their communities, about social-ecological risks, and that part of the ways in which they learn should include their community members in teaching roles within their schools (*ibid*).*

*In his response to Mueller et al. (2012), Weinstein (2012) argues that education as democracy needs to be situated in a wider landscape of democratic (and undemocratic) practice more broadly. He argues that in a wider context of rapidly neoliberalising democracy, grounding in economic rationalities which shape both scientific priorities and governance structures, democracy must take on a more radical and oppositional form, rather than be reduced to participation in citizen science (*ibid*). Weinstein points out that*

*schools decreasingly have space for the type of pedagogy of time and place that a more democratic citizen science, or *ciencia popular*, requires. Thus, the tensions and attractions between schools and citizen science projects are not so much about democracy, as I see them, but about parallel, and genetically related, hierarchical (nondemocratic) models: the first involving the teacher as the expert intermediary between the student and knowledge, and the second*

offering students direct access to the expert on whom the students are supposed to imprint. More specifically, schools and technoscience are entangled institutions. It is not so much *science and education as science/education* (*ibid*: 2, emphasis in original).

Weinstein (2012) concludes that the current institutional arrangements of schools and science disable the possibility of learning as enactments of democracy, and themselves require challenge and redefinition, before the vision of Mueller et al's (2012) citizen science as democratic practice becomes possible.

5.6.3. Citizen Science as Post-Abyssal and Counter-Cultural

Laypersons are never separate from the contexts where science and technology are investigated and applied as agenda. Science is never separate from the values of those who have a stake in it. ... In terms of citizen science, there may even be times when collaborating with scientists will not be in the best interest or even possible for those who want to organize to express their views, which necessitates a greater emphasis now on the dialogical spheres of historical, indigenous, archival, community, or virtual relationships (Mueller, Tippins & Bryan, 2012:7).

Scientism leads to a romantic conception of what science is, which motivates many to become involved in citizen science projects. Science in scientism is a cosmology apart, not one among many. ... but science here and elsewhere has to be understood as evoked by convenience (Weinstein, 2012:1).

In contrast to institutionalised definitions of, and articulations of citizen science, there are also a range of counter-cultural and potentially post-abyssal articulations. These are most often visible in grassroots and community-based approaches to citizen science, but are also evidenced within particular institutional settings, and are substantially less evident in the field of literature. Nor is this area of literature uniform in what they propose.

Nomadic and countercultural citizen science: Drawing on the radical science movements which called for scientists to enact stronger forms of citizenship, McQuillan (2014) offers a framing of citizen science drawing on these ideals as a pathway towards strengthening the potential for a form of citizen science. McQuillan's arguments foreground open participation, social justice, situated intervention, transformation and visionary imagination (*ibid*). His notion of what countercultural means includes the mobilisation of a vital critique of scientific worldviews which,

work on and through cultural formations ... is a diverse and hybrid space without a unity identity ... is lived as a transformative experience where the participant is fundamentally changed at a psychic level through participation in unique events ... is associated with a unique moment in time, a point of shift from the old to the new. ... It offers a challenge not at the level of detail but, to the fundamental assumptions of the status quo (*ibid*:1).

McQuillan also proposes a citizen science which is 'nomadic science' (after Deleuze and Guattari, 2013). Here, nomadic science "does not have ambition to totalise knowledge" and that "can valorise truths that are non-dual and that go beyond objectivity to include the

experiential” in ways which incline towards the local, the situated and the culturally reflective
(McQuillan, 2014:2). McQuillan points out that,
[t]his does not mean replacing or overthrowing science but constructing an other to science with
its own claim to empirical methods (*ibid*:2).

*While much of his article is concerned with the production of a particular form of scientific
knowledge which both enables and foregrounds epistemic access as well as empirical
alternatives to science, he also includes in this process other forms of knowing and the
significance of including such knowing in risk-responsive knowledge production.*

Citizen science for peer-to-peer societies:

*Wildschut (2017) considers the possibilities for strengthening peer-to-peer forms of
sustainability knowledge enabled by citizen science approaches. In contrast to dominant
conceptualisations, she defines citizen scientists as “people who practice science outside of an
academic or industrial environment”, (*ibid*:46). Based on a critique of neoliberal governments
and their often contentious institutionalisation of knowledge production, governance, and
corporate interests, Wildschut envisions citizen science as a way to bypass institutional controls
and agenda, towards knowledge production in response to shared manifest risks (*ibid*). As with
McQuillan’s arguments above (2014), Wildschut positions citizens and their potential processes
of knowledge production in opposition to State and institutional structures.*

Although Wildschut raises issues of contributory and distributive justices, acknowledges the value of
local knowledges, promotes notions of participatory and radical democracies and recognises the value
of commons, her arguments maintain a hegemonic notion of science and its role as a knowledge about
other knowledges (*ibid*). Instead, what she seems to be arguing for are more open processes to, and
systems of scientific knowledge production itself. Systems of legitimation, in the peer-to-peer society,
remain scientific, while the author suggests that the openness of these systems might serve to
challenge shortcomings in academic settings (through data openness, publication of negative results,
which citizen scientists are apparently more likely to do, or to resist the pressure to publish at all),
(*ibid*).

*In their paper on taking participatory citizen science to extremes, Stevens et al.¹¹⁰ (2014) share
methodologies and tools for working with marginalised communities using indigenous
knowledges and science together, to support more effective participation in the sustainable
management of key environments. They argue that if citizen science,*

*Is to fulfil its promise of stimulating public interest, participation, and representation in scientific
research—and in the policies that such research is expected to inform—all citizens should, at*

110 Stevens, M., Vitos, M., Altenbuchner, J., Conquest, G., Lewis, J., & Haklay, M.

least in principle, have a chance to participate and benefit. This is especially true for those that are the hardest to reach due to geographical, cultural, political, educational, or socio-economic circumstances. Similarly, if pervasive computing is to succeed in making computing a truly ubiquitous force for good in our societies, then it's important to look beyond the urban jungles in which most technologists reside and to develop tools that work even in the most extreme circumstances (*ibid*:20-21).

Stevens et al. point out that most citizen science projects are set in (industrially) developed countries, and participants are expected to have some level of formal education and familiarity with information technologies before joining a project, and even then, participation is often limited to particular phases or processes within a project (ibid). The authors also caution that the simple intention to include marginalised communities in citizen science is insufficient, and that care must be taken to avoid issues of cultural misunderstandings, the deployment of inappropriate technologies, misinterpretations of purposes for engagement, inflated community expectations, misreadings of power dynamics, and ineffective or divisive incentives (ibid). The authors foreground the role of flexible, co-created, and well-designed protocols to mediate knowledge work; protocols are not limited to scientific knowledge production, but rather include protocols for interaction and the establishment of shared research goals, as well as protocols for research transparency before research has begun, as well as knowledge production protocols. Describing systems of transparency and goal co-creation, Stevens et al. note,

*[I]n the context of environmental justice projects, we spend a lot of time co-developing with the community effective advocacy strategies and partnerships. We never assume the community's willingness to participate and will only ask them explicitly to give their consent once we're satisfied that the issues are understood by an inclusive majority. The terms of participation are left open for discussion, and we take care to avoid unrealistic expectations on either side. ... If the community expresses an interest in participating, the next phase is an exercise in concretion and iterative participatory design (*ibid*:22).*

Part of the process of iterative design is working with communities to establish which forms of information and which types of knowledge they believe are important, and whether they are willing to do so (after collective consideration of the consequences) (ibid). Because the technologies used are designed to be inclusive of both literate and illiterate participants, the symbols generated to symbolise particular meanings are negotiated, and a process of symbolic literacy is engaged in collectively (ibid). Each community decides "what, with whom, and to what extent to share their data" (ibid:23). While their paper outlines participatory and co-creative elements of project design, the primary focus is on the development of context-appropriate technologies, and enabling symbolic literacies among collaborators. Data is used to inform applied management and governance strategies related to situated environments and land share practices. There is little articulation of how indigenous knowledges are integrated, beyond discussions about co-created research priorities and symbol development.

As can be seen, there are a range of counter-cultural and potentially post-abyssal discussions within the field of citizen science. These seem to align more strongly with the framing of citizen science proposed by Irwin (1995), while in some ways, going beyond his articulations. The purposes for such forms of citizen science differ vastly from those articulated by Bonney (1996), both in terms of socio-political imperatives, and in terms of epistemic priorities and cultures.

5.7. Chapter Conclusion

Benefits and challenges of and to citizen science are discussed in markedly different ways within the two broad approaches to citizen science identified in this chapter, as are epistemic purposes and goals. Within modernist scientific approaches, both benefits and challenges are related to scientific productivity, and concern citizen scientists' abilities to contribute legitimate scientific knowledge (or at least data), and scientists abilities to access, analyse and publish scientific findings from citizen scientist contributions. Within schooling contexts, this is framed in terms of scientific literacy development and the involvement of learners in authentic scientific learning experiences. This encompasses both project contexts, informal and formal learning contexts, across the lifelong learning system. Data management, hegemonic systems of institutionally-mediated ethics, and distributed technologies are also raised.

Expanding this from a post-abyssal vantage point, challenges and benefits are framed in terms of critical literacies which enable participatory and potentially radical forms of democracy, and which leverage and legitimate multiple forms of knowledges. Increasing depth participation, representation, legitimation of diverse forms of knowing, arguing for alternative systems of legitimation, challenging scientific systems of legitimation and knowledge translation are all identified as priorities. The disruption of hegemonically modernist scientific systems of knowledge production, and the ability to build collective knowledges that are complex, diverse, and situated, are forwarded as central concerns.

A careful distinction in claims is called for here. While I have outlined generally hegemonic or expansively post-abyssal approaches to citizen science as reflected in the peer-reviewed literature, it would be imprecise to conflate concern for issues of justice and participatory or radical democracy with one approach or the other. While expansively post-abyssal approaches seem to centralise epistemic and justice concerns, and promote participatory democracy

processes more strongly, this does not mean that more strongly hegemonic approaches to citizen science exclude such concerns. Rather, it is more likely that justice and democracy concerns are framed hegemonically or post-abysally, so that hegemonic approaches perceive and define such concerns within established public good framings, while counter-hegemonic approaches are more likely to challenge such framings.

The analysis in this chapter highlights the overwhelmingly hegemonic and scientifically privileged representation of citizen science in the peer-reviewed literature - this is not an unexpected finding. Peer-reviewed journals are part of the legitimating system of scientific knowledge production and act to delimit what counts as knowledge, based on scientific legitimating criteria. What is more significant is that the peer-reviewed literature is incomplete, and in many ways, inaccurate, when read against the field of practice. The field of literature privileges and foregrounds modernist scientific knowledges because this is the system of legitimation it is geared towards fulfilling. Therefore, it should not be used as the sole or most important accounting system for the field of practice. To use this body of literature to determine what citizen science is or is not, and to mediate with policy institutions on its basis, perpetuates systems of hegemonic rationality and its related injustices. Rather, this body of literature must be read for what it is - an account of modernist scientifically-privileged aspects of knowledge which are important for the production of scientific knowledges through citizen science approaches, but which fall short of a full account of epistemic activity within the field. The literature is useful for understanding *modernist scientific* knowledge production, but is incomplete as an account of common knowledge production overall.

CHAPTER 6

Mapping practice - who's
who in the citizen science
zoo

6.1. Introduction

As noted in 1.2, citizen science has seen an increasing uptake over the last two decades especially. This form of epistemic activity is being mobilised in increasing numbers of ways across a range of social contexts and scales, and in response to a wide range of social-ecological risks. Citizen science approaches are being leveraged by government agencies, NGOs, university researchers, and groups of concerned citizens, all under the umbrella of the term 'citizen science'. However, a review of literature portrays a highly diversified field of epistemic practices.

In this chapter, I present an epistemic mapping of citizen science projects from the field of practice in South Africa. This includes an analysis of pertinent epistemic features within various types of projects and models of citizen science, as well as initial insights into the relationships between various epistemic elements within these projects. Conceptualisation of such epistemic features are presented in 2.2 and 2.7. Additional details on the methodology employed to develop and administer the tool are presented in 4.2.2, and a copy of the mapping tool is included in Appendix 4¹¹¹.

The presentation of this chapter is broadly informed by the work of Cetina (2007) and Latour (2004). In it, I present project mapping data including various epistemic features. This data was generated during the second research cycle, before I was challenged to reconsider the decolonial call for more just forms of knowledge production. It follows a primarily hegemonic perspective on knowledge production, firmly rooted within the western sciences. Important to note, is that this cycle of data collection occurred when the production of scientific knowledge was seen as the primary aim of citizen science projects. During this phase of data collection, I intended to understand how epistemic relationships might be strengthened to enable stronger and more just epistemic access to scientific knowledge production. Correspondingly, the mapping tool elicited responses in relation to the production of scientific knowledge production.

Epistemic features analysed (drawing on Cetina, 2007, 1999; see 2.4):

- Epistemic purposes

¹¹¹ An earlier version of some aspects of this chapter is published as Vallabh *et al.* (2016).

- Epistemic subjects, including epistemic roles and statuses
- Epistemic objects
- Epistemic relationships, practices and mediating processes
- Scales of activity
- Epistemic outcomes

In the analysis, I categorise the epistemic features of sampled projects, before describing shared tendencies within groups of epistemic cultures. I then provide an analysis of broad approaches (based on project purposes) in relation to Latour's distinctions between 'matters of fact' and 'matters of concern' (2004). This epistemic mapping, and the typologies which have emerged are intended to support the epistemic analysis of projects informed by their knowledge practices, rather than as an attempt to classify or categorise them into any form of hierarchy or schema. My claims emerging from this analysis are preliminary, given the limitations of sampling, and the limited geographical (South Africa) and disciplinary scopes of projects sampled (earth and environmental sciences).

6.2. Initial Indications of Epistemic Complexity From the Field of Practice

During the pilot phase of this study, analysis of three selected South African citizen science projects highlighted the diversified field of practice (see 4.2.1). In 2018, Lotz-Sisitka *et al.*¹¹² did an initial review of citizen science practice within the water quality and monitoring sector in South Africa, and described in detail, seven projects and their epistemic and social features (see Appendix 8). Each of the seven cases, once again, highlighted the highly diversified nature of the field of practice. Lotz-Sisitka *et al.* (*ibid*) identified the following configurations of differentiated systems of governance, leadership and partnership interactions and alliances, including:

- National NGO and social movement alliances;
- Civil society-led, multi-stakeholder partnerships;
- National governance partnerships;
- Corporate social investment-led partnerships;
- Academic institution and NGO alliance-led civil society partnerships;
- Local government leadership of multi-stakeholder engagements; and

¹¹² Lotz-Sisitka, H., Ward, M., Taylor, J., Vallabh, P., Madiba, M., Hampson, P., Graham, M., Brownell, F. & DitiHale, N.

- National NGO and government dialogue partnerships.

The authors discovered that each configuration of partnerships gave rise to particular epistemic cultures, and forms of epistemic focus, resonating with the initial pilot findings for this study.

6.3. Epistemic Purposes

Project purpose is one of the dominant features used to distinguish citizen science projects from each other. In the initial literature review, I identified four broad purposes (see 1.2.3) for which citizen science approaches were being leveraged:

- **Scientific research**, including survey data collection and hypothesis testing research activities (e.g. Silverton, 2009; Conrad & Hilchey, 2011);
- **Environmental monitoring**, including monitoring of natural resources such as land-use, and air and water quality (e.g. Bonney et al., 2009a; Conrad & Hilchey, 2011);
- **Environmental advocacy**, including those projects arising from social or environmental crises in local contexts (e.g. Irwin, 2001; Ottinger, 2010; Stodden, 2010; Conrad & Hilchey, 2011); and
- **Education** - educational purposes were implied more often than explicitly stated in the papers reviewed in the early phases of this research. Few citizen science projects appeared to be established primarily as educational programmes, even though many programs presented both explicit and implicit educational outcomes, tools and resources. However, there are a growing number of projects being developed for schools, with a range of purposes across different projects (Boney et al. 2009a; Silverton, 2009).

The identification of these four types of purpose strongly influenced the development of the epistemic mapping tool. They were used to inform groups of questions within the mapping tool, but were later replaced with findings from analysed data (presented below), and a more intentional reading into typologies of citizen science (see 5.5).

However, one of the challenges of this broad, and admittedly crude, categorisation was that many programs also seemed to cross between categories, and reported multiple evolving purposes. As with many other social processes, citizen science projects appeared to be shaped by, and responsive to a range of factors, including: intended scientific design; both planned and emergent forms of social engagement and associated learning opportunities; relationships between epistemic subjects and other project influencers; epistemic objects and the ways in

which they constrained or enabled social interactions within projects; and the overall project foci. During the mapping process, project coordinators were asked the following questions to inform an updated, field-based mapping of epistemic purposes:

B1: What is your project's focus area?

C1: What is the purpose of your project?

C2: What are your key project activities?

C3. Please list the INTENDED scientific benefits of your project.

C4: What is the data generated through your project being used for?

While projects reported a clear project focus, how this focus was achieved often involved multiple project purposes. Many projects also reported expanding systems of activity over time - often initiated by partner organisations or citizen scientists themselves. For example, *CREW* and *SeaKeys* project managers both reported citizen scientists leveraging common knowledge being built in the program, towards local conservation actions and awareness-raising activities. This expansive tendency negated clear discrete categorisation of projects based on epistemic purpose. To accommodate this tendency, I have chosen to represent project purposes relationally within their wider epistemic cultures. Based on the findings of the literature review (Chapter 5) and the epistemic mapping data, seven purpose categories for citizen science projects were identified, based on epistemic purpose. Categories are tabulated in Table 7 below.

Table 7: Seven broad purpose categories used to describe citizen science practice

Purpose of Programme	Description of Categorisation
<i>Computing and digital citizen science projects</i>	In these projects, citizen scientists contribute computing power through home-based digital devices, but do not collect data <i>per se</i> . Foldit at Home is an example of such a project. No South African-based projects were identified in this category, but they were mentioned in interviews and visible in the literature. I was also participating in Foldit at the time.
<i>Species mapping</i>	Projects focused on the collection of species data over time (for example, bird atlasing), often initiated by academic institutions including masters and doctoral candidates.
<i>Management of natural resources</i>	Projects focused on the collection of data used to inform various levels of policy and resource management at strategic levels, often initiated by government or institutions collaborating with governments.
<i>Applied conservation actions</i>	Projects focused on the collection of data used to inform applied conservation actions (often initiated by NGOs and civic groups).

Purpose of Programme	Description of Categorisation
<i>Landscape-wide ecosystem monitoring</i>	Projects focused on engaging citizens in monitoring and civic actions across a particular ecosystem (for example across a water catchment), often initiated through a network of partners operating within the same ecosystem.
<i>Community action, activism, and learning</i>	Projects focused on taking action in response to specific social-ecological risks (for example, pollution affecting human health), often initiated by civic groups or individuals.
<i>Situated and wider social learning</i>	Projects focused on using citizen science approaches as a tool to support social or individual learning within specific contexts. These projects are initiated by a diversity of organisations, depending on the perceived future outcome and focus of learning activities.

Project purposes were represented on a heuristic, and specific projects mapped into the heuristic, represented in Figure 22. The lines between categories are represented permeably to indicate the expansive epistemic natures of the projects mapped, with the expanse of project purpose represented based on the concentration of knowledge focus. This expansion does not necessarily reflect linear development of cumulative characteristics. As with all heuristics, there are representational limitations to how purposes have been mapped.

Table 8. Key to Mapped Projects

ANIMAL DEMOGRAPHIC UNIT (ADU) PROJECTS	PROGRAMMES RUN BY OTHER ORGANISATIONS & GROUPS
1. Birds in Reserves (BIRP)	32. Conservation of Rare and Endangered Wildflowers (CREW)
2. Bird Picture Archive	33. EWT Migrating Kestrel Project **
3. Birds with Odd Plumages (BOP)	34. EWT Ground Hornbill Project **
4. Bird Roadcounts (CAR)	35. EWT Roadkill Project
5. BirdPix	36. EWT Sasol Vulture Monitoring Project **
6. Coordinated WaterBird Counts (CWAC)	37. ifoundahedgehog (ifah)
7. EchinoMap	38. limbovane Outreach Project
8. FrogMap	39. Isimangaliso Sea Turtle Citizen Science Initiative
9. Hadede Ibid Project	40. iSpot (Citizen Science Species Mapping Portal)
10. LacewingMap	41. Khulumani Water for Dignity
11. LepiMap*	42. Mathuba Schools and Citizens River Health Programme
12. MammalMap*	43. MiniSASS
13. MushroomMap	44. Oceanographic Research Institutes Cooperative Fish Tagging Project (ORI-CFTP)
14. MyBirdPatch	45. SA Jelly Watch
15. Nest Records (NERCS)	46. SeaKeys Sea Fish Atlas ***
16. OrchidMap	
17. OdontaMap	
18. Ornithological Observations	
19. Penguin Watch	
20. Photos of Weaver Nests (PHOWN)	
21. ReptileMap	
22. Southern African Bird Atlas Project (SABAP)	
23. South African Bird Atlas Project 2 (SABAP2)*	
24. South African Butterfly Conservation Assessment (SABCA)	

ANIMAL DEMOGRAPHIC UNIT (ADU) PROJECTS	PROGRAMMES RUN BY OTHER ORGANISATIONS & GROUPS
25. Southern African Reptile Conservation Assessment (SARCA)	47. SeaKeys Sea Slug Atlas ***
26. ScorpionMap	48. SeaKeys Sea Coral Atlas ***
27. SeaBird Atlas	49. The Calendar Gardens
28. South African Bird Ringing Unit (SAFRING)*	50. ToadNUTS
29. SpiderMap	
30. TreeMap	
31. Virtual Tree Herbarium (ViTH)	
<i>*ADU programmes mapped through interviews. An interview was also done with the manager of the ADU to gain insight about historical and virtual projects.</i>	<i>** Same project manager - single interview for three project maps, hosted by the Endangered Wildlife Trust (EWT).</i>
	<i>*** Same project manager - single interview for three project maps.</i>

Figure 22 is a purposes heuristic populated with the projects mapped. Projects reporting multiple project purposes are mapped more than once. Where a clear primary purpose was identified, this is highlighted by a number bubble in black; secondary and tertiary purposes are mapped in white bubbles, as are projects with no clear primary purpose.

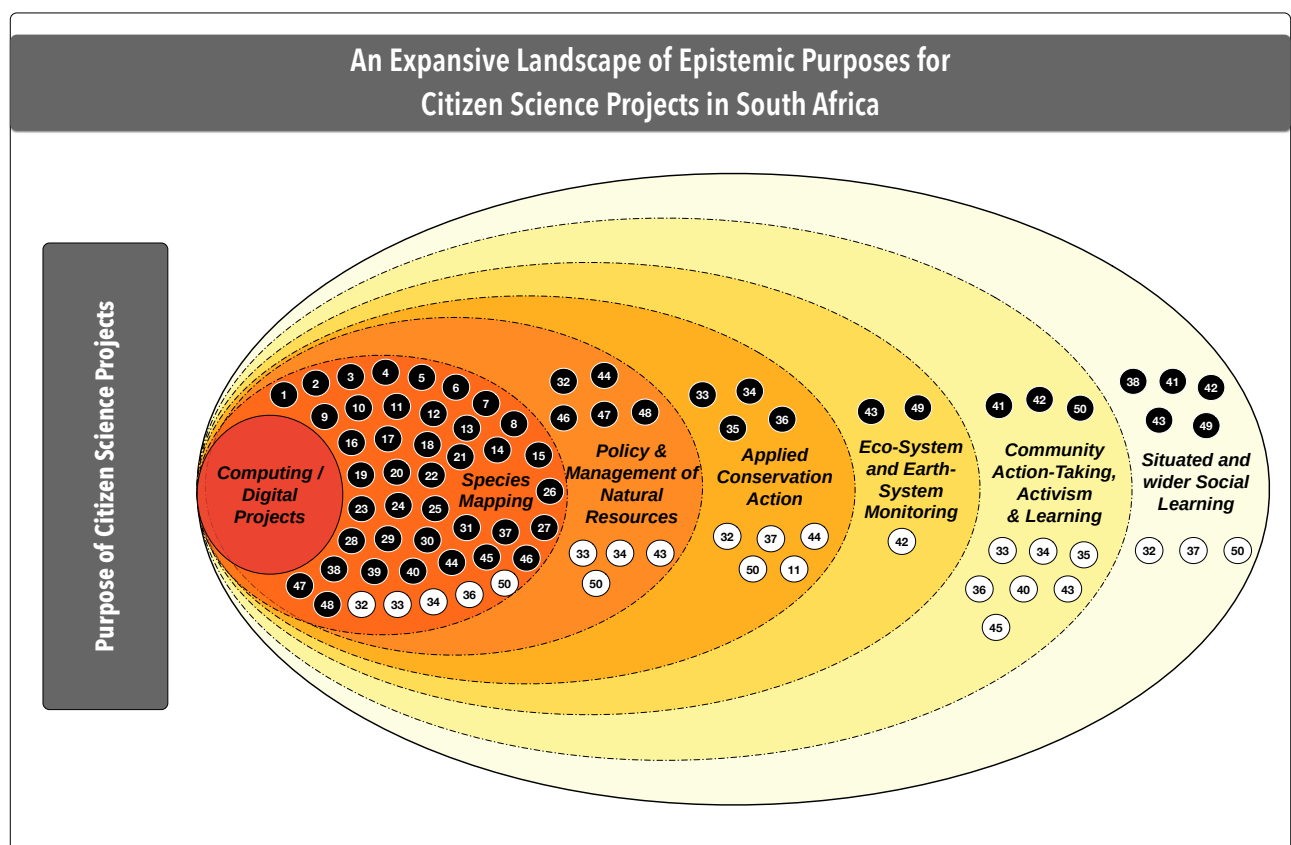


Figure 22: Heuristic of mapped epistemic purposes

Of the 50 projects mapped, 46 projects reported some form of 'biological species mapping' as a project purpose. Interestingly, two of the projects (*MiniSASS* and *Mathuba River Health Programme*), whose primary purposes were 'situated and wider social learning' and 'ecosystem monitoring', also made use of some form of species monitoring in their learning and monitoring activities. *Khulumani Water for Dignity*, whose primary purpose was community activism, also made use of species monitoring during learning and river health monitoring activities. Projects housed within government institutions also tended to use citizen science approaches which centralised species monitoring. 13 projects reported more than one project purpose. Many projects also reported education and awareness raising as unofficial project purposes, with project managers explaining that although education and awareness-raising were not considered primary purposes of the projects, they were facilitated where possible.

iSpot was implemented and hosted by the South African National Biodiversity Institute (SANBI), a national government institute mandated with biodiversity management. Projects hosted on *iSpot* therefore also informed policy development and the monitoring and management of national biodiversity; however, this purpose was not reflected in the mapped heuristic because this was not clearly identified as a project purpose. Similarly, projects hosted by the ADU also fed into national biodiversity management databases, but were not identified as primary purposes.

While the populated heuristic clearly indicates a dominance of species monitoring activities among the mapped projects, later research interactions evidenced a large number of unsampled projects within the field of water quality monitoring (see Lotz-Sisitka *et al.*, 2019). This indicates a weakness in the sampling method used, indicating that local projects, projects without a primary interest in scientific knowledge production, and projects without visible public platforms were far less likely to be sampled, as were those not connected into networks and communities of practice of some kind. For example, *Khulumani Water for Dignity*, which is a local collaboration, was only identified because it was active in the university town I was resident in; *MiniSASS* was identified because of previous exposure to the programme, and the *Mathuba River Health Programme* was identified because a colleague in the ELRC was a facilitator on the programme.

The majority of project managers interviewed were able to describe one clear project purpose related to the type of scientific knowledge they intended to build, as well as a range of other purposes related to how, and with whom they went about building this knowledge. The exceptions to this were projects categorised in the community activism, action and learning, and situated and wider social learning categories. Projects in these two categories foregrounded the mobilisation of knowledge towards situated change and social learning as project purposes.

In many of the projects, project purpose was clear, and generally related to the collection of scientific data of a particular kind. At the same time, how the generated data was being used was socially embedded, and generated in response to different aspects of social-ecological risk, rather than to purely inform the production of scientific knowledge. This aspect is analysed in 6.10, where I discuss whether projects were focused on the production of 'matters of fact' or 'matters of concern' (Latour, 2004).

Although it was not possible to categorise projects into discrete purpose types because of their expansive tendencies, it was possible to identify general trends and shared tendencies among groups of projects with similar project purposes. Tendencies related to the types of learning being supported, epistemic roles, and the ways in which epistemic relationships were mediated. These will be presented in the sections below.

6.4. Epistemic Subjects, Roles and Relationships

Information about epistemic subjects, their roles, and the relationships between epistemic subjects was sought to clarify epistemic power and gain insight into knowledge production roles. The roles and interactions between epistemic subjects provided a second layer of insight into the epistemic cultures of citizen science projects. Once again, informed by the field of literature on citizen science as well as initial findings within the pilot study, the mapping tool contained the following questions related to epistemic subjects and their roles:

B2. How many citizen scientists do you have participating in your programme currently?

B3. Participant demographics: Who is participating in your project?

B4. What is the geographical scale of your project?

B6. What are your main sources of funding?

B7. What is your project governance structure?

B8. How many different organisations are affiliated with this project?

B9. What is the diversity of organisations / institutions affiliated with this project?

C5. Please list the intended social outcomes of your project.

G1. Which areas of participation for citizen scientists does your project support?

Projects were mapped based on dominant and formally acknowledged epistemic roles and responsibilities, as described by project managers.

6.4.1. Demographics of Epistemic Subjects and Organisations

The mapped projects reported a range of epistemic subjects. Others were inferred through partnerships and funding relationships. Figure 23 summarises self-identified¹¹³ epistemic subjects within sampled projects. Note that 27 ADU projects categorised only under formal project partners, scientists, and participation open to everyone categories because of the primarily digital nature of the projects, and because specific demographic information was not collected.

Projects including school children and teachers tended to do so within particular project activities only, rather than as part of wider project activities, and school children were more often engaged without their teachers, except in the *limbovane* and *The Calendar Gardens* projects, which purposefully focused on curriculum support. While 47 projects indicated that participation was open to everyone, many project managers included skills or resource-based qualifiers. For example, participation was open to everyone in *SAFRING*, so long as they were certified bird-ringers, and had access to appropriate bird-ringing equipment - participation was restricted based on *certification and access to resources* (certification was facilitated within the project). Similarly, participation in *CREW* and *ORI-CFTP* was also open to everyone, provided that they had appropriate rare plant identification skills, and fishing or diving skills respectively - participation here was based on *skills level*. *Khulumani Water for Dignity* was also open to participation from everyone, but project activities were *geographically limited* to the Makana Municipality, which was the project's focus area. Finally, many species monitoring projects indicated open participation, but were limited by *resource requirements* for monitoring (for example, binoculars, field guides, and transportation to monitoring sites). Projects operating on

¹¹³ A pre-identified list of epistemic subjects was supplied, with project managers self-identifying epistemic subjects, and expanding on the list of supplied subject categories.

digital only systems, such as *iSpot* or the majority of the ADU projects, were limited by access to *networked technologies and internet access*, as well as the *digital literacy* required to submit data through webforms. Almost all participation by citizen scientists was limited by *time availability* - citizen scientists needed to be able to volunteer specific amounts of their time in order to participate successfully in projects.

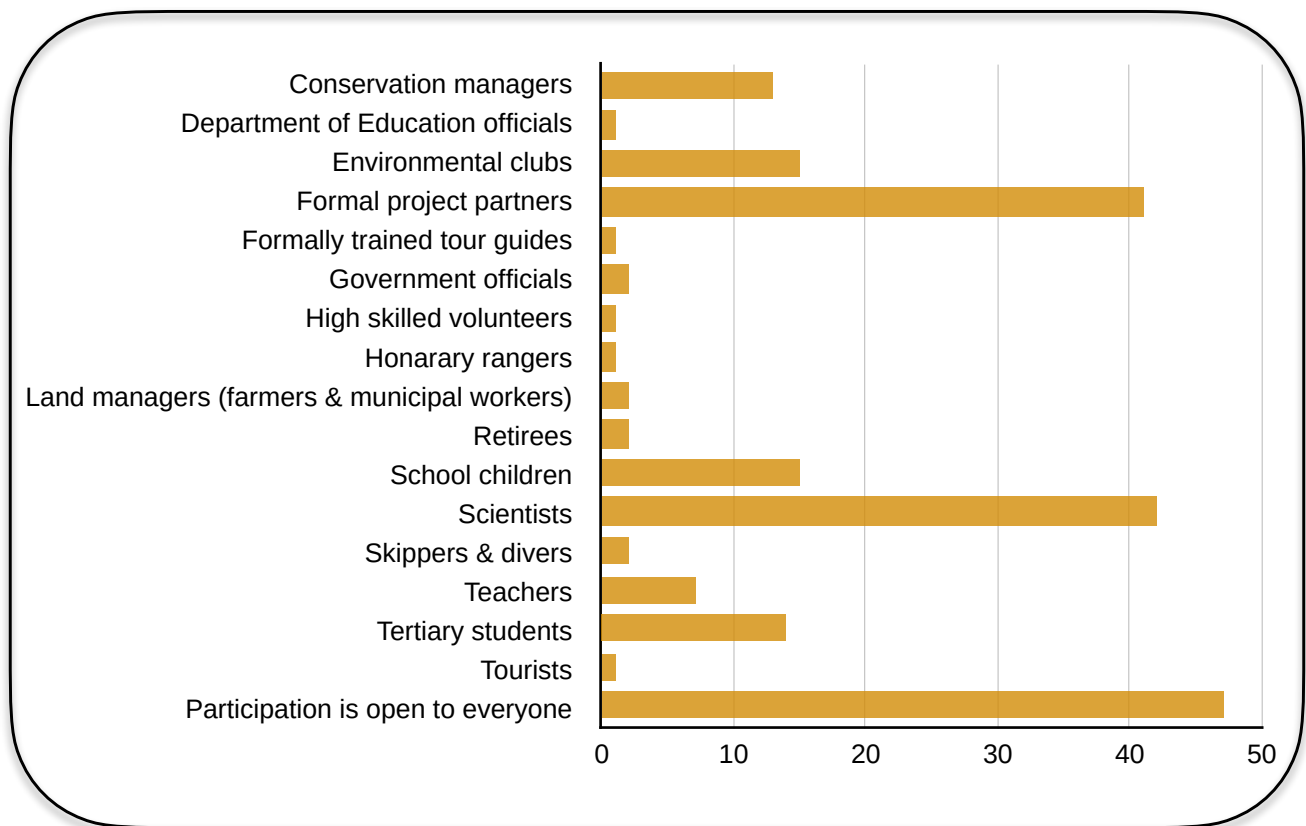


Figure 23: B3: Self-reported Participant demographics

6.4.1.1. Organisational and institutional partnerships

Organisational partnerships were also mapped, recognising that organisations themselves enact specific epistemic cultures, and that these cultures influence epistemic priorities, relationships and processes of knowledge production. The majority of projects included some form of partnership between academic institutions, civic organisations and government institutions. The three case studies in Chapter 7 illustrate the differentiated nature of these three forms of partnerships in more specific detail, as well as how the knowledge production priorities mandates of various organisations influence epistemic foci and govern epistemic relationships. Citizen scientists were primarily recruited through strategic partnerships with local interest groups and through membership affiliations within local non-profit organisations.

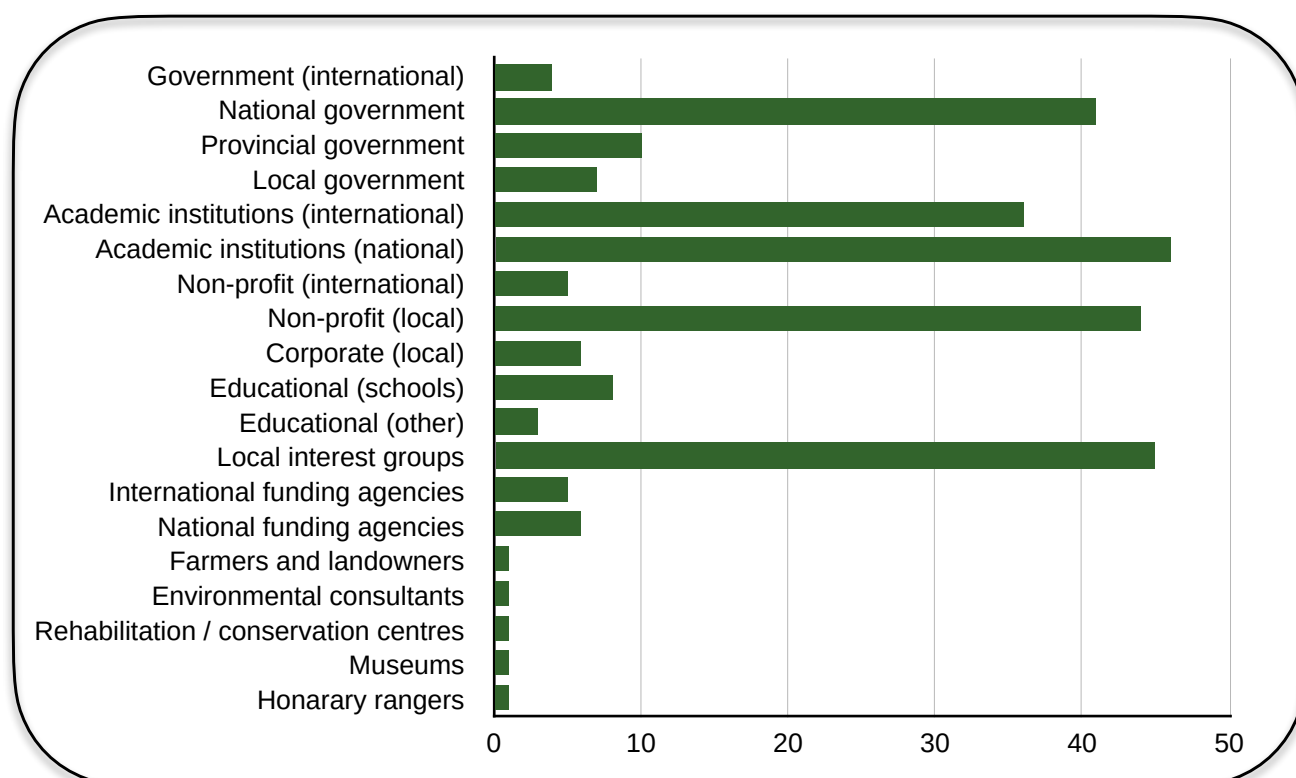


Figure 24: B9: Diversity of organisations participating in citizen science projects

Finally, funding partnerships were also mapped. Although funding partners appear to have a clearly designated role which might appear to fall outside of epistemic practices, their institutional cultures often have epistemic influences and generate epistemic priorities. For example, both the ADU and EWT's bird monitoring programmes are highly influenced by SASOL - a corporate funder who has committed large amounts of corporate social responsibility funding to bird conservation. SASOL in turn, requires projects to meet particular funding requirements which speak to their social marketing strategies and are targeted at generating marketing visibility of their brand. This translates to resource allocations towards particular types of epistemic activity, as per funding agreements. Similarly, research funding is geared towards the generation of particular forms of knowledge, resourcing some knowledge production activities while excluding others. *Ifoundahedgehog* and *Isimangaliso Sea Turtle Initiative* are examples of this, where projects are being managed by institutionally funded postgraduate students, whose primary goal is to generate data for their dissertations. *CREW* and *SeaKeys* are partially funded through government resource management allocations, and so resource allocations are prioritised towards the fulfilment of SANBI's¹¹⁴ institutional mandates. Such

¹¹⁴ Both projects are hosted by the South African National Biodiversity Institute (SANBI) - a government parastatal mandated to manage national biodiversity resources.

arrangements are common between funders and projects, and therefore have bearing on the configuration of epistemic cultures within citizen science projects.

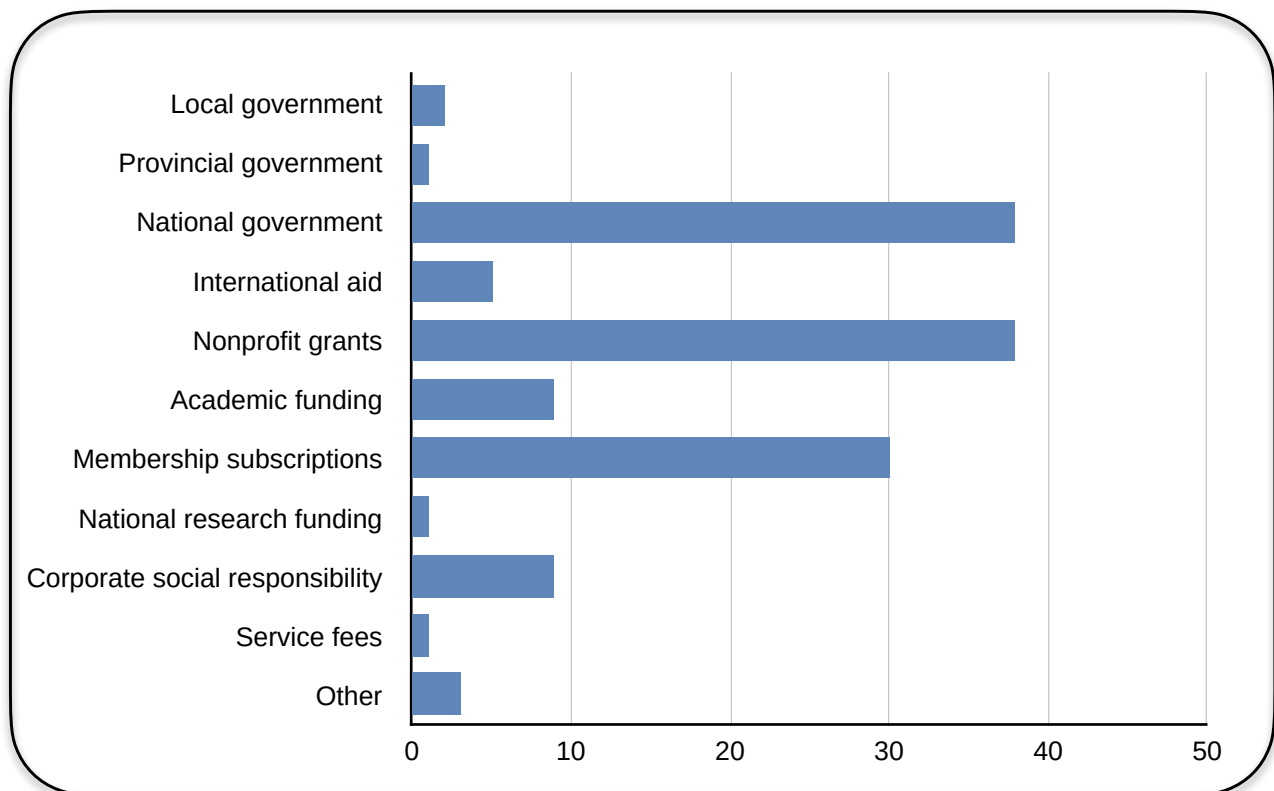


Figure 25: B6: Main sources of funding

6.4.1.2. Project governance structures

Six projects self-identified as enacting functional or consultative governance structures, where citizen scientists provided a functional contribution to the project, but project conceptualisation, management, and knowledge production remained the function of the convening scientist. In these projects, there were clearly differentiated epistemic roles, without any intention to transform knowledge epistemic practices beyond formal, hegemonic systems of knowledge production. 40 of the 50 projects self-identified as having a collaborative, multi-partner system of governance, where a group of partners initiated and ran projects together. Interestingly, many projects with hegemonic knowledge production structures still considered themselves to be collaborative, taking the differentiation of knowledge and contribution roles as naturalised. These projects often operated within networks of partnerships, with diverse partners leveraging different resources and contributing to diverse aspects of knowledge production. Finally, five projects self-identified as implementing transformative or grassroots governance structures, in that they were initiated by civic groups or engaged in grassroots activism and knowledge production.

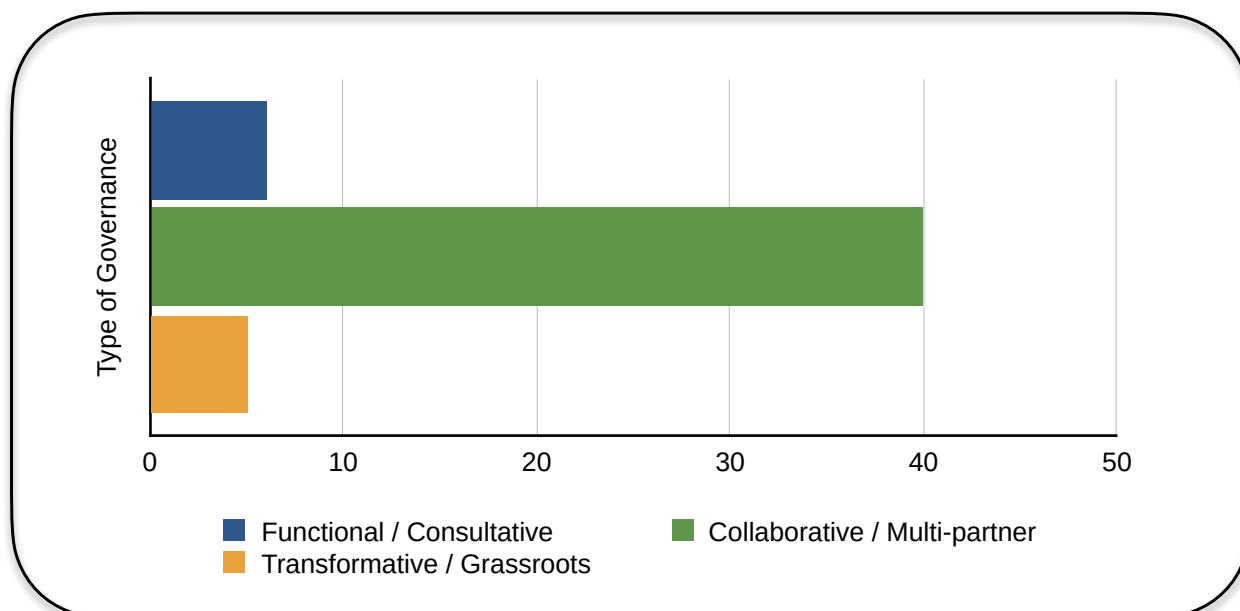


Figure 26: B7: Self-identified project governance structures

CREW self-identified as having a dual system of governance including both functional / consultative governance structure (in that it is implemented and governed by an institutional State mandate) and grassroots / transformative governance structure (in that it is co-governed by a civic organisation engaging in active citizenship, and engages a variety of other civic organisations). *Khulumani Water for Dignity* also identified as engaging a dual system of governance including both collaborative / multi-partner approaches (accounting for a range of academic and civic activist partners), and transformative /grassroots approaches (in that the core team operated as citizen activists within their community). Each of these projects are examined more closely as case studies in Chapter 7.

6.4.1.3. Epistemic roles and statuses

Programmes convened a range of epistemic subjects into various roles within different types of projects. Epistemic roles were afforded distinct epistemic statuses. Knowledge production roles (analysis, synthesis and scientific reporting) were dominantly professional roles with elevated epistemic status; those holding these roles were in a position to legitimate and validate the contributions of citizen scientists focused on data contributions alone.

As with epistemic purposes, epistemic roles appear to have a tendency towards expansiveness. Although epistemic roles are clearly delineated in most projects at conception, a number of project managers reported an expansion of these roles as projects progressed and citizen

scientists developed sufficient common knowledge to contribute to additional project roles. These roles were often considered unofficial - the distinction between professional and citizen scientist roles remained distinguishable in spite of a blurring of epistemic tasks.

The location of professional vs amateur also shifted, depending on the type of project. For example, projects governed by State agencies still operated within more hegemonic knowledge production systems. These projects included institutional scientists as well as citizen scientists who are either currently or were previously, professional scientists. It was therefore possible for some citizen scientists to hold more elevated epistemic statuses than the institutional scientist managing programmes. In *CREW*, for example, node managers generally hold masters degrees, while a number of citizen scientists in those nodes hold doctoral degrees. Epistemic authority was divided between these roles in interesting ways. The institutional arrangements of these projects also influenced the division of epistemic roles. Scientists within State institutions managed which knowledge was produced, and how that knowledge was used, while scientists within civic organisations leveraged expert species knowledge and held epistemic authority in matters regarding species identification, distribution patterns, and historical distribution patterns. Epistemic roles were still governed along hegemonic lines, with epistemic authority accruing most strongly to professional scientists, with the distribution of authority across different types of organisations.

Another tendency was for citizen scientists to define their own roles outside of formal project activities, drawing on common knowledge built within the project (for a more detailed articulation of these two tendencies, see the *CREW* case study in Chapter 7). The projects housed within SANBI especially (*CREW* and *SeaKeys*), reported this expansive tendency among citizen scientists. In these projects, citizen scientists began to make scientific discoveries and co-publish papers, as well as mobilising common knowledge in response to contextual risks through expanded networks of activity (such as 'friends of' groups and community groups).

However, while this tendency was evident in most project categories, projects coordinated by academic institutions had a tendency towards hegemonic systems of knowledge production, with a clear distinction in roles between citizens and scientists. Part of the reason for this may be the type of data being generated by citizen scientists within these projects, as well as the often highly automated systems of data collection. Within these projects, data was most often

collected via web-based data forms, which limited the ways in which citizen scientists were working with data, or collaborating with each other or other epistemic subjects.

Hegemonic processes of knowledge production were reflected in data legitimisation processes, where citizen scientists' generated data was 'cleaned' through various processes of validation, before being utilised for scientific knowledge production. This process is, of course, not unlike 'data cleaning' processes within any contained scientific investigation - what is distinct here is that the role is split between professionals and citizen scientists, so that professionals (or in some cases, highly-skilled citizens who formally held professional scientist roles) 'clean' and thereby legitimate the data being produced by citizen scientists - in other words, epistemic authority is primarily conferred through formalised systems of legitimisation.

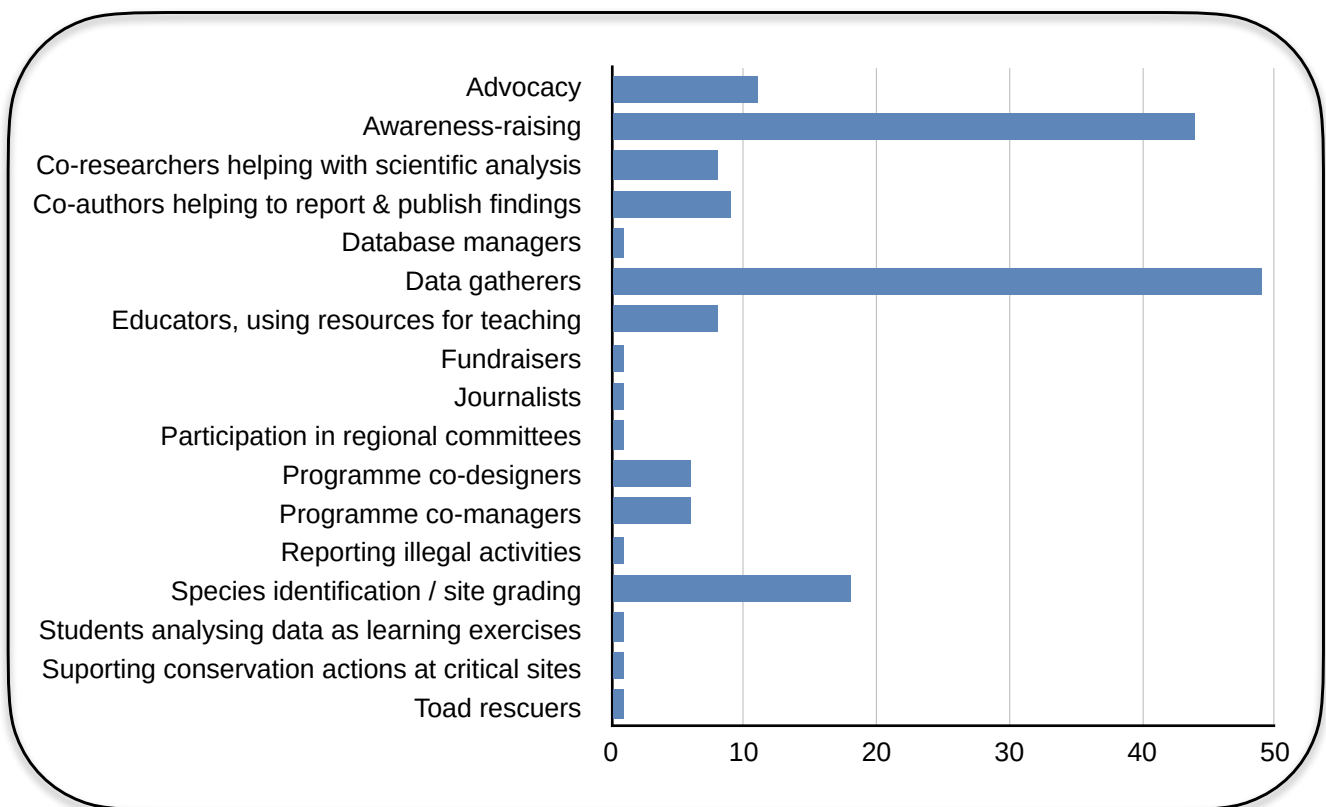


Figure 27: G1: Areas of citizen scientist participation

Citizen scientists were dominantly engaged in data generation and awareness-raising activities - especially in projects focused on species mapping. However, awareness-raising seemed to be a secondary interest for most project managers, and was rarely intentionally facilitated through formal project activities. Instead, there was an assumption that being engaged in data

generation in projects which intend to eventually inform applied conservation practices, automatically equips citizen scientists to raise awareness about threats to species.

6.4.1.4. Mobility among epistemic roles

Projects like *iSpot* and *CREW* enabled some degree of mobility within these roles, offering mechanisms to increase skill level, and thereby gain greater epistemic status within a given epistemic culture. *iSpot* achieved this through a tiered system of activities, where citizen scientists could access higher tiers of activity by completing certain numbers of correct species identifications and other such rating systems. *CREW* enabled mobility through a range of monitoring and applied conservation tasks, as well as through dedicated contributions to fieldwork within nodes of activity.

Many species monitoring projects also offered a form of epistemic status for the number of data sheets submitted, or the number of correct identifications. This form of status was conferred through social media networks in the form of contribution certificates, achievement badges, and competition announcements, for example. This form of status was also used as a currency for encouraging ongoing participation in projects. This form of mobility retained the distinction in epistemic roles, instead offering tiers within role categories. In contrast, projects focused on informing applied conservation (such as EWTs *Roadkill* and *Vulture Monitoring* projects) enabled mobility in epistemic roles based on commitment to applied conservation interventions (for example, through allocation of dedicated monitoring sites with resourced monitoring stations).

Within the *situated and wider social learning* category, three dominant epistemic relationships were evident. The first followed a more traditional model of science education, where scientists engaged learners in scientific tasks for learning purposes but did not use the analysis generated through such tasks; here the roles followed a hegemonic model where scientists supported learners in developing their scientific literacies, but never co-produced knowledge with learners (*limbovane Outreach Project* is an example of this approach). The second model involved learners in generating data and analysing data at basic levels, but maintained a distinction in roles between scientists supporting the development of scientific literacies and learners practicing to be scientists - data was collated into further scientific processes but learner generated analysis was used only for learning purposes (*The Calendar Gardens* project is an

example of this approach). The third and most expansive approach was visible within *Khulumani Water for Dignity* and the *Mathuba River Health Programme*, where epistemic cultures were designed to support mobility among epistemic roles, with a range of formal and informal project activities designed to increase scientific capacity and strengthen scientific literacy.

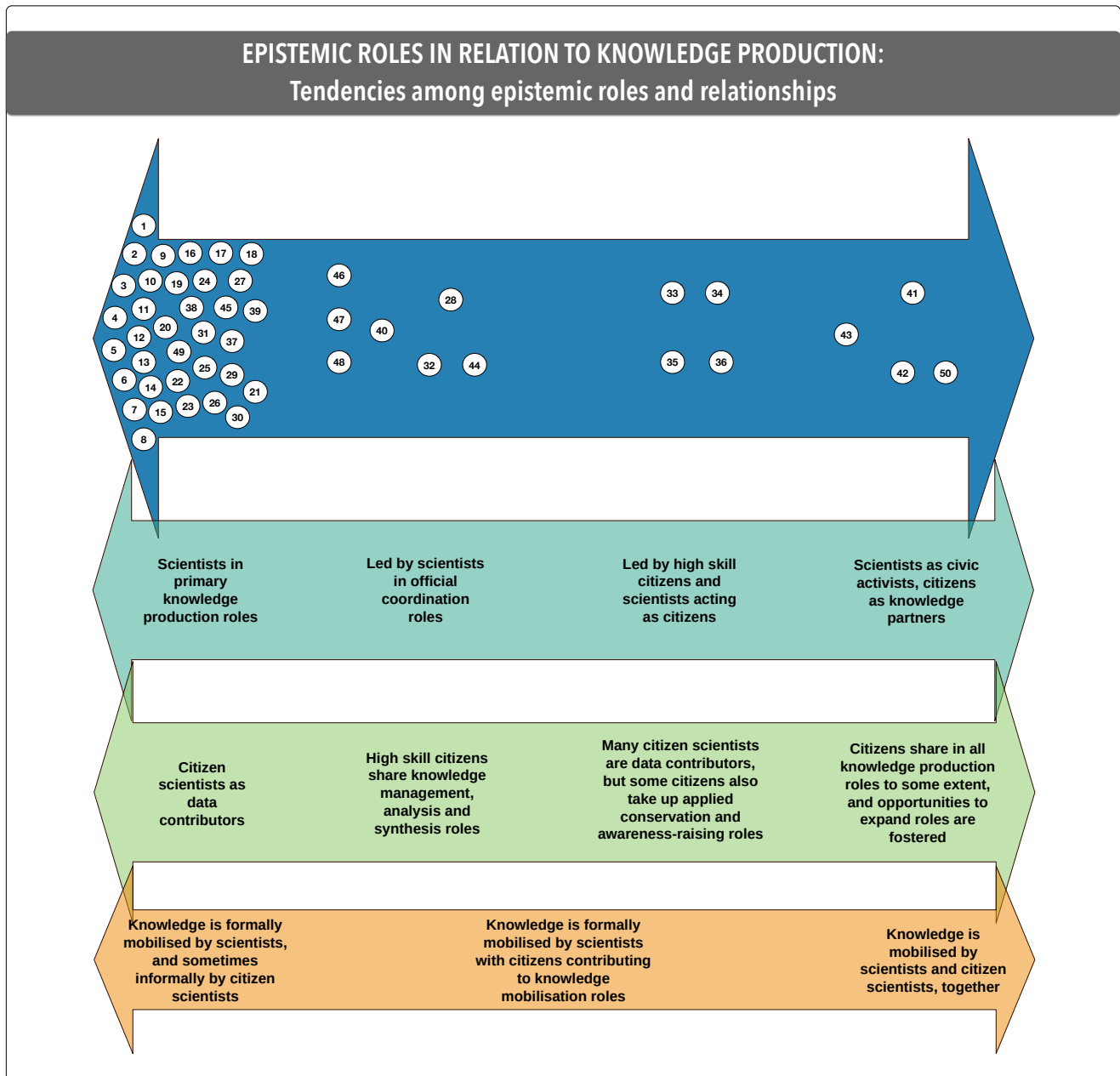


Figure 28: Relational heuristic of epistemic roles

Within both of these programmes, citizen scientists were encouraged to produce knowledge and enact legitimating processes on knowledge being produced; citizen scientists were supported to collect data, analyse data and mobilise the knowledge being produced in response to self-defined actions. Mobility in epistemic roles were integrated into the primary purposes of knowledge production within these projects.

Professional scientists also took up a range of epistemic roles within projects. Traditional scientist roles were evident in projects hosted within academic institutions, while scientists located within governance institutions adopted expanded roles which included scientist, policy informant and implementer, resource advocate and civic collaborator. In contrast, scientists located within NGOs adopted roles which included scientist, conservation officer and activist. Scientists collaborating with civic activists themselves adopted activist stances, albeit through leveraging scientific expertise in service to a particular civic action. There was also some mobility evident in the roles that professional scientists played within different epistemic cultures, although this was predominantly in terms of project management, learning support or training and outreach functions, where scientists expanded their roles as project activities expanded. Within all but one of the projects, epistemic authority remained primarily with professional scientists either in roles as knowledge producers, knowledge translators, or science educators. The exception to this was the *Khulumani Water for Dignity* project, which is presented more fully as a case study in Chapter 7.

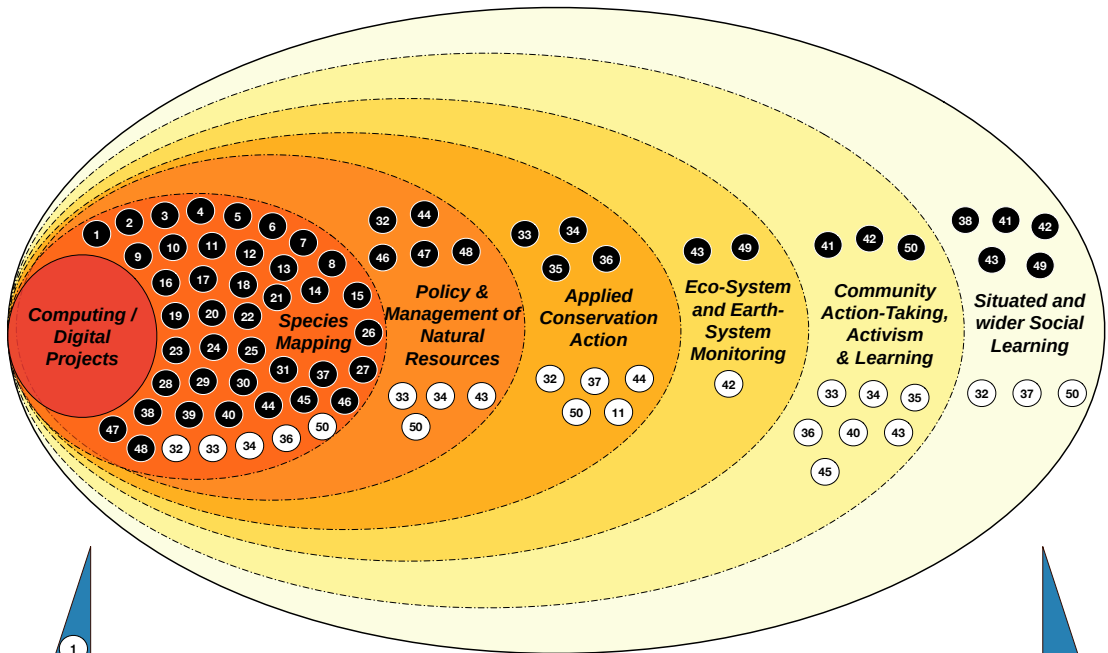
6.4.1.5. Recognising shared tendencies

When epistemic roles mapped against the purposes heuristic, a range of shared tendencies become noticeable across epistemic cultures. Figure 29 combines the mapping of epistemic purposes with a range of epistemic roles. Due to the expansive nature of epistemic practices evidenced in many of the mapped projects, discrete categorisation would not accurately reflect citizen science practices among these projects. Recognising tendencies does, however, provide a broader view of the field of practice, in addition to offering some insight into various approaches to citizen science, and the forms of learning, epistemic access, and forms of justice they are most strongly configured to support or limit.

As illustrated, species mapping approaches to citizen science tend to primarily involve citizen scientists in data generation roles, and maintain more hegemonic approaches to knowledge production within formal project activities. Questions of epistemic, contributory, and distributive justices are particularly pertinent within such approaches, as are issues of epistemic access.

An Expansive Landscape of Epistemic Purposes for Citizen Science Projects in South Africa

Purpose of Citizen Science Projects



Epistemic roles and relationships

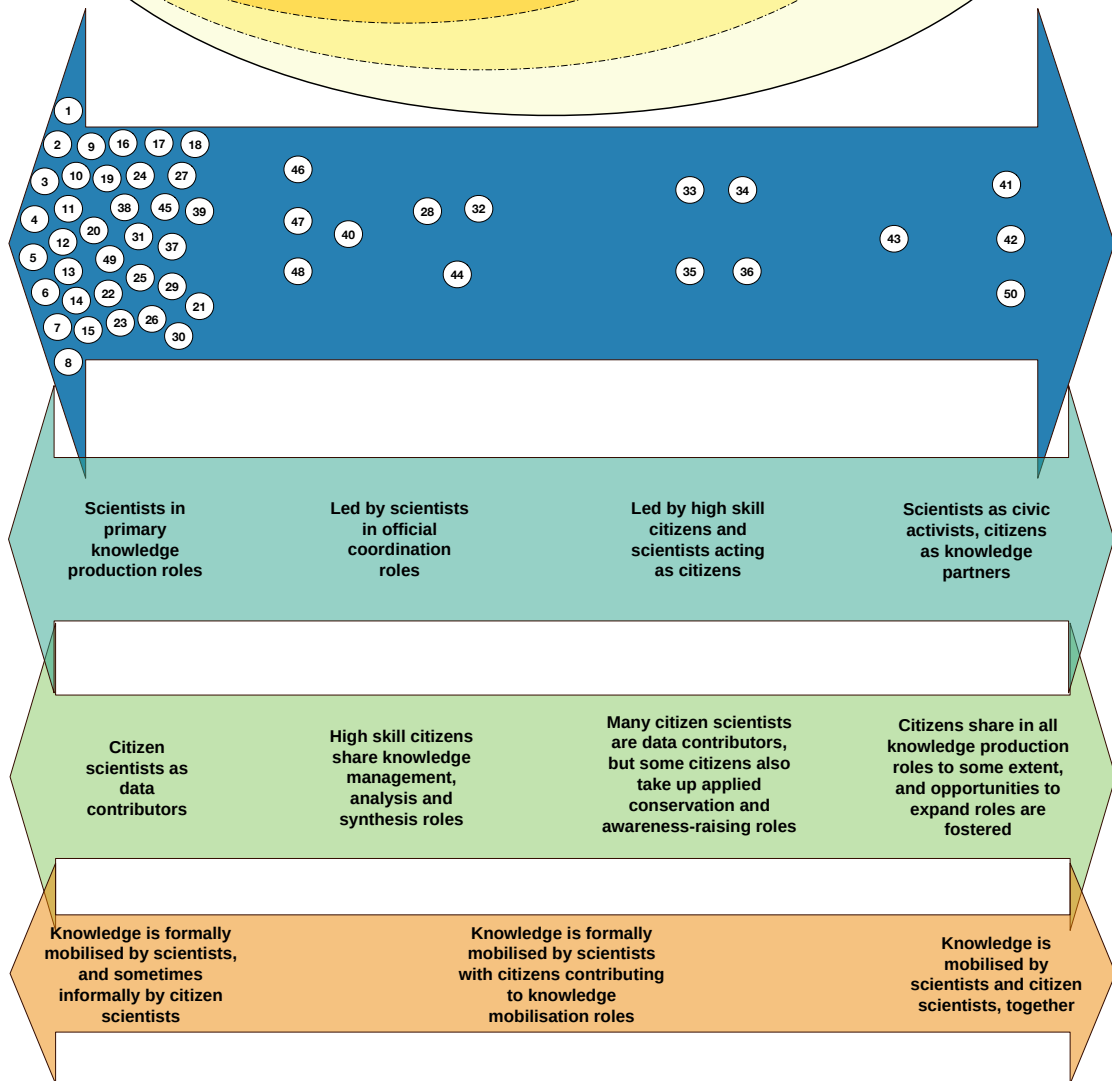


Figure 29: Relational heuristic of epistemic purposes and roles

Projects focused on policy development and natural resource management at large scales have a tendency towards greater mobility in epistemic roles, but primarily focused on roles which facilitate the implementation of organisational mandates. They do, however, seem to connect into a wider range of local networks through civic partnerships which translate common knowledge into localised actions. Issues of deliberative, participatory and radical democracy have special significance within these approaches to citizen science, as they involve epistemic interactions between government institutions and a range of civic partners. Projects in the remaining categories have a tendency to increasing amounts of expansiveness in both epistemic purposes and roles, and actively enable a flattening of epistemic statuses as part of programme approaches. Here, considerations of how social-ecological risks are collectively framed, and which knowledges are used in response to such risks, and how and why issues of justice are engaged, become especially pertinent.

6.5. Epistemic Objects and Mediating Artefacts

The mapped projects reported using a range of epistemic objects to mediate interactions between epistemic subjects. The mapping tool included the following questions aimed at informing understandings of epistemic objects:

E2. What data collection resources does your project provide?

E3. What identification or classification resources does your project provide?

E4. What strategies does your project use to engage citizen scientists?

G1: Which areas of participation for citizen scientists does your project support?

A weakness in data generated about epistemic objects is that data collected for this feature was primarily in the form of selections from listed objects, and therefore confining most responses to my preconceptions of how projects were being resourced. Although a number of project managers provided detailed descriptions of how and why epistemic objects were being used in their projects, many others confined their responses to options within the lists provided. A stronger integrity of data could have been achieved through the inclusion of qualitative question about how and why different resources were used in projects. A brief discussion is provided here, and picked up again in the next section on epistemic practices and mediating processes, which speak to the forms of epistemic interactions enabled by subject-object relationships.

Unsurprisingly, all of the projects reported the use of scientific protocols in one form or another, including in the form of data sheets and data collection protocols, monitoring protocols, and identification keys. Such protocols were focused on strengthening data collection and identification integrity, and thereby enhancing the legitimacy of data being generated. Scientific protocols took different forms across different purpose orientations.

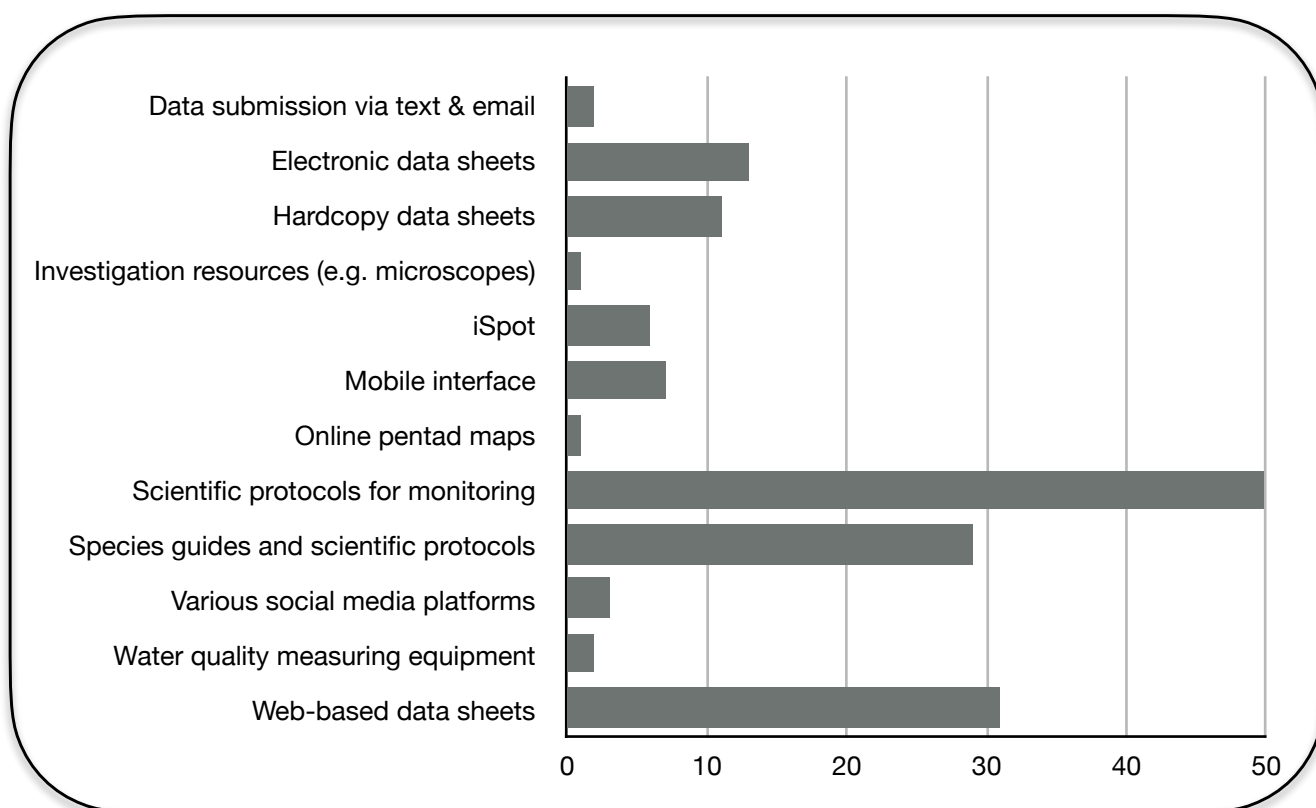


Figure 30: E2: Data collection resources used in Mapped projects

Within species monitoring projects, protocols focused on capturing specific species information which supported species identification and increased the accuracy of geographic mapping data. For example, *iSpot* contains a range of required data fields, and contributors are encouraged to include a number of photographs, as well as a GPS tag, in addition to clarifying how certain they are about their identification¹¹⁵. Many projects categorised within other project purposes included risk assessment, site monitoring and condition assessment information. For example, *MiniSASS* data sheets include condition assessments, while *CREW* data sheets include risk assessment, and electronic systems include geographic blurring¹¹⁶ to protect threatened

¹¹⁵ Such claims are then moderated by higher tiered participants, and reputation credits are earned for correct assessments. A sufficient number of correct assessments open up higher tiers of participation.

¹¹⁶ By this, I mean that precise geographical locations are uploaded by citizen scientists, but publicly visible records have obscured geographical locations to protect threatened species - especially those with economic values.

species, and monitoring protocols include steps to inform private landowners of threatened species and protocols for protection, where relevant. In this approach to citizen science, data was generally collected only through pre-designed forms, with pre-established protocols. *Ifoundahedgehog* was unique in that species data was collected through a variety of means, without a specific scientific protocol; data was then analysed and translated into a scientific protocol by the postgraduate student whose research such data informed.

Within resource management, ecosystem monitoring and situated and wider social learning approaches, scientific protocols were more strongly geared towards supporting citizen scientists to develop monitoring skills. For example, *Mathuba River Health Programme* and *MiniSASS* both included learning support resources explaining what made protocols scientifically legitimate, and how monitoring data translated into river health grading. More detailed monitoring processes were included, as were explanations about how and why monitoring was taking place in particular ways. Additionally, explanations were provided for how data was used to inform condition assessments, and why such assessments were scientifically legitimate. These projects also employed various forms of scientific equipment such as water clarity tubes, microscopes, and other monitoring resources, whose use was moderated through scientific protocols.

Within projects oriented towards applied conservation, a range of approaches to data collection, and associated protocols were reported. Data contributions were generally accepted in multiple formats, including fairly informal reports via social media, email or text message, and did not have to be submitted within a pre-arranged protocol, although such protocols were also available. This was likely because data was primarily being used for risk assessment and intervention, and secondarily to inform scientific knowledge production. The *EWT Roadkill Project* is a good example of this tendency - the project accepted roadkill reports in any and all formats, but preferred data that included accurate geographical and species information. In part, this was because roadkill data is not always easy to collect - accurate species identification is often difficult, and it is often risky to complete an assessment on busy roads.

Scientific protocols within projects oriented to community activism and action-taking, on the other hand, appeared to be designed to support the translation of other forms of knowledges (situated or embodied knowledges, for example) into scientifically recognised and legitimated

forms of data, and to support civic partners to record data which informed their situated experiences of risk. *Khulumani Water for Dignity*, for example, included scientific protocols which translated situated knowledges into systematised data that could be processed scientifically, in addition to using water quality assessment protocols.

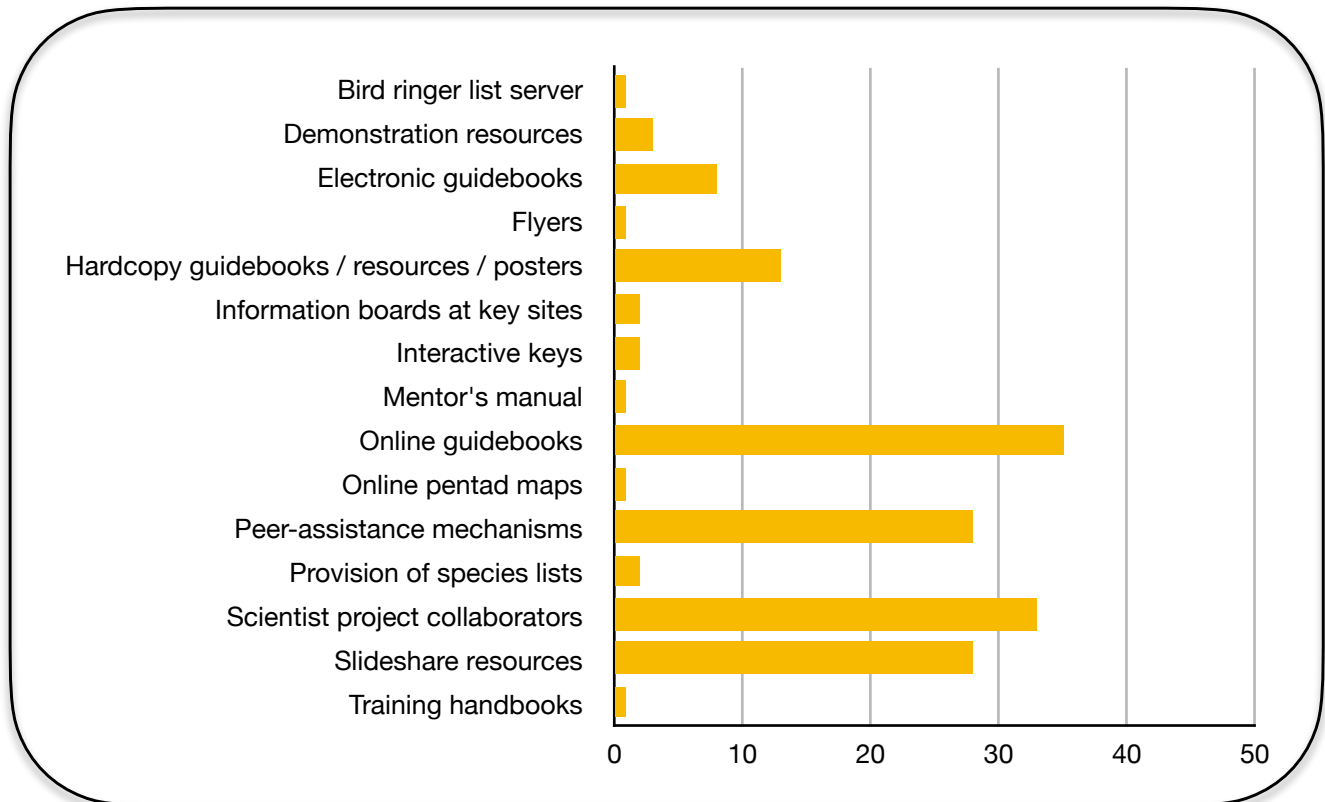


Figure 31: E3: Project identification or classification resources

Projects oriented towards community activists and action-taking, and wider and situated learning purposes were the only projects which formally collected qualitative data, supporting citizen scientists to use quantitative data to inform qualitative experiences. This is most strongly evidenced within the *ToadNUTS*, *Khulumani Water for Dignity*, and *Mathuba River Health* projects. Further illustration of this is evidenced in the *ToadNUTS* and *Khulumani Water for Dignity* case studies in Chapter 7. In most other projects (and especially within species monitoring projects), what might be described as subjective experiences were separated out into informal project interactions using epistemic objects such as discussion forums and social media platforms. Participation via these objects were encouraged, but remained separated from official data collection strategies - they were often described as social interactions, rather than scientific ones.

6.6. Epistemic Relationships, Practices and Mediating Processes

This section describes tendencies related to the interactions between epistemic subjects and objects, and how those interactions were geared towards achieving particular epistemic outcomes. Included are descriptions of the range of strategies employed to engage citizen scientists, as well as training and educational activities. In addition, I consider the forms of epistemic interactions enabled through particular epistemic object formats.

Mapping questions used to inform understandings of epistemic relationships, practices and mediating processes included the following:

B7. What is your project governance structure?

C2. Please list your key project activities.

D1. Does your project engage in training or education activities? (With clarification for each).

E4. What strategies does your project use to engage citizen scientists?

G1. Which areas of participation for citizen scientists does your project support?

I1. Please provide details of significant findings from your project implementation experiences.

I2. Please provide details of any lessons learnt and recommendations from your project implementation experiences.

Project coordinators reported a range of strategies used to engage citizen scientists in project activities. However, not all of these activities were geared towards knowledge production. Many strategies were leveraged to encourage participation using lessons from game theory to motivate and 'reward' citizen scientists for data contributions.

For example, achievement badges and contribution acknowledgements were a popular strategy among projects such as *iSpot* and *LepiMap*, which were mediated by web-based technologies. Community discussion forums were appended to many species monitoring projects to encourage social interaction and peer-to-peer learning and support, without these interactions being facilitated by formal project staff, or informing formal knowledge production processes. Newsletters were used as a mechanism to share citizen science experiences, and to share both individual and project achievements within a particular period, and often highlighted special contributions of particular citizen scientists, or informed citizen scientists about upcoming project changes.

Within *ToadNUTS*, for example, social media (especially WhatsApp) was used as a coordination, networking, and knowledge sharing platform, and was directly related to building common knowledge. Other projects reported a similar use of social media platforms, especially in terms of peer-to-peer knowledge building and mentoring.

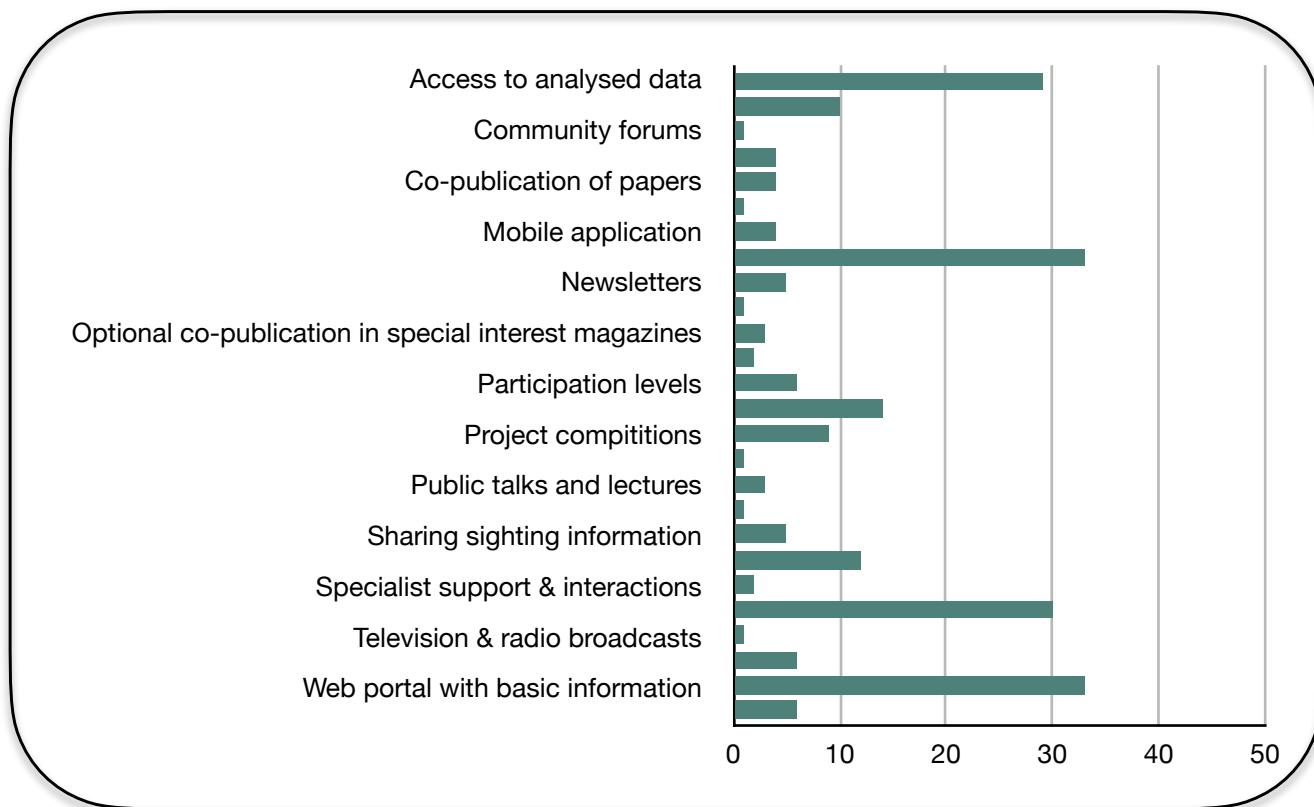


Figure 32: E4: Strategies used to engage Citizen scientists

6.6.1. Education and Training

45 of the 50 projects mapped, indicated some form of training or educational activity. However, most project managers qualified this by indicating that such activities were informal or fell outside of the primary purpose of the project. Learning was often assumed, rather than formally facilitated or evaluated. The development of scientific literacy commonly was seen as a means to achieve stronger data quality, with project managers assuming that citizen scientists were developing scientific literacy by participating in data collection activities. Blogs, expert talks and lectures, media articles or interviews, and 'how to' manuals were encompassed within educational and training activities. In addition, many projects offered species-specific courses to support citizen scientists to develop their identification skills, as well as skills development courses such as bird ringing courses, specimen collection and sampling courses, and monitoring

courses. These forms of scientific literacy development dominated approaches to education and training identified by project coordinators.

Projects offering school support fell into two categories: a) guest lectures about particular species or projects, and b) formal curriculum support activities. In the former approach, project representatives were invited to present a special interest talk to a group of learners. Although there was a soft intention to stimulate interest in science in general, and the project in particular, lectures were not intended to provide curriculum support *per se*. *LepiMap*, *MammalMap* and *SAFRING* are examples of this form of school-oriented learning.

In the latter category, formal relationships between schools and projects were established, with projects offering sustained activities to either grades of learners or environmental clubs within schools. In these cases, activities were specifically designed to both align with curriculum requirements, and engage learners in project focus areas. *limbovane Outreach Project*, for example ran a 10-year school programme, through which learners were taught about the scientific method of species grid sampling, data collection, and analysis using ants (*iimbovane*) as the species focus. Teachers were supported to develop and deepen their scientific literacy in correlation with curriculum-based activities presented to learners. Researchers supported learners through a range of ongoing school-based activities. However, data analysed by learners were not used to inform the researchers' scientific studies into ant mapping. In contrast *MiniSASS* data generated by learners was uploaded onto the national water quality map, and considered viable data.

Khulumani Water for Dignity engaged learners in a range of activities, including through convening school water forums, which mirrored the community water forums established to engaged the broader community in activism around water quality. Learning support in this instance, was geared towards developing skills around active citizenship. The school water forums were accompanied by water quality monitoring using *MiniSASS*, as well as water quality auditing within school grounds, followed by interventions, based on audit findings. Learning in this instance was responsive to situated risk, and expansive in nature. Educational activities were also presented for community members, including the establishment of community water forums, a range of skills and knowledge-based community workshops, and awareness-raising events. The core group of citizen scientists in this project were engaged in an ongoing series of

learning activities, in part facilitated by the two founding partners in the project (an academic institution and a national NGO). The core group then engaged in a range of expansive learning interactions in collaboration with other project partners. Similarly, the *Mathuba River Health Programme* engaged learners in a series of situated, social learning tasks with the intention of building capacity to both develop systemic understandings of risk, as well as respond to situated risks based on such understandings. Again, learning in this context was expansive in nature, evolving as learners and other project participants investigated situated risks.

Interestingly, projects hosted by government institutions (*CREW* and *SeaKeys*), both engaged in formal, curriculum-based teacher training and school outreach work. This may be because of a dedicated education department within SANBI, which facilitated and managed school-based programmes on behalf of all institutional projects.

Most projects presented training courses focused on improving quality of data collection. *ToadNUTS* and *Khulumani Water for Dignity* were unique in that they provided training focused on risk-responsive intervention, *ToadNUTS* in terms of toad-rescue practices, and *Khulumani Water for Dignity* in terms of situated water quality management practices. Peer-to-peer approaches are also often employed in projects where collective monitoring occurs. For example, *CREW*, *ORI-CFTP*, *ToadNUTS* and *SAFRING* all encourage and facilitate processes of peer-to-peer learning, either through expert-accompanied fieldtrips, or through systems of mentorship for newer or less accomplished citizen scientists. Few of the training courses offered are accredited. *Mathuba River Health Programme*, *SAFRING*, and projects offering formal teacher training courses are among the few affording this form of epistemic currency to project participants.

6.7. Epistemic Outcomes

An understanding of epistemic outcomes was generated through the following questions:

B2. What is the purpose of your project?

C3. Please list the intended scientific benefits of your project.

C4. What is the data generated through your project being used for?

C5. Please list the intended social outcomes of your project.

E5. Please rate the validity of the data generated by your project.

F1. What are your project's intended / hoped for conservation impacts?

F2. What are the conservation impacts of your project, to date?

H1. How do you measure success within your project?

H3. Please list the partially or fully successful outcomes of your project.

H5. Please list any unintended outcomes of your project.

While descriptions of epistemic purposes tended to be specific and focused on which knowledge the project aimed to produce, descriptions of epistemic outcomes were more future-oriented, and encompassed a wider system of activities than those implemented within a project itself. Coordinators encompassed the intended uses of produced knowledge including applications of knowledge into other systems of activity, as well as direct project outcomes. For example, many species mapping projects described input into policy formation and applied conservation as intended outcomes, even though project activities were confined to data collection and analysis processes. In part, this might be because of the interconnected systems of knowledge production, policy development and resource management, and because coordinators were involved in these systems in various ways beyond the scope of citizen science projects.

Projects housed in academic settings, unsurprisingly, prioritised scientifically legitimated epistemic outcomes, and were often linked to postgraduate studies, with the production of dissertations considered a primary outcome for the project, in addition to an emphasis on various forms of scientific publication. The successful production of scientifically robust knowledge was considered an outcome in and of itself.

Projects within institutional settings outside of academia tended to produce knowledge systems that were more closely and immediately connected to systems of application. For example, species monitoring projects housed within SANBI developed knowledge in ways that were immediately translatable and useable in policy development and applied resource management; this included implementation across a range of contexts and scales of resource governance (see *CREW* case study in Chapter 7 for a more detailed example). In contrast, projects housed in academic institutions required policy translation processes, where such processes were not pre-established. The majority of species monitoring projects contributed data towards Red Data Lists, regardless of which institutions they were housed in. Within these

types of projects, the production of robust scientific knowledge was only considered an outcome if it met the policy and governance needs host organisations were mandated to fulfil. One of the critiques that the project manager of *iSpot* (hosted by SANBI) offered was that it was important to consider how knowledge needed to be used, and that one of the shortcomings of *iSpot* was that it was easy to input data, but difficult to 'take it out again' through the public interface; in other words, knowledge was not as accessible as SANBI's implementation teams required for easy translation into contexts of practice.

Similarly, projects housed in civic organisations tended to produce knowledge in forms that were applicable to conservation interventions in the short and medium terms. Knowledge was considered as legitimate and valid when it enabled intervention and risk mitigation - either through policy process at macro levels, or within specific situated contexts of risk. Knowledge produced within such projects are also most often openly shared with other projects geared towards achieving similar threat mitigation activities.

Projects with strong civic partnerships, or those arising from the interests of civic groups foregrounded interventionist outcomes directly related to perceived risks within situated contexts. Skills development which increased epistemic access to science and systems of governance were perceived as valuable outcomes, but only where they enabled communities to mobilise in response to manifest risk more effectively. Projects with primarily educational purposes perceived the development of scientific literacies within teachers, learners or other groups of citizen scientists as primary outcomes. Secondary outcomes included the application of knowledge in response to situated risk within learners' contexts. There were also a smaller group of projects who reported that most or at least some of the data being generated were not being leveraged towards particular outcomes for various reasons. *ToadNUTS* and *SA Jelly Watch* were examples of such projects.

6.8. A Summary of Shared Tendencies Among Citizen Science Projects

Table 9 summaries a range of shared tendencies informed by the analysis of mapping data. Tendencies are articulated in relation to formal aspects of epistemic cultures, recognising that informal and expansive aspects of projects have a tendency to expand epistemic cultures in unforeseen and unplanned ways.

Table 9: Shared tendencies among citizen science projects

Purpose of Citizen Science Project	Shared Tendencies Among Citizen Science Projects
Citizen Science for Species Mapping	• Collection of large-scale, species-specific data • Scientists lead projects, and projects are most often based in academic institutions • Citizens contribute data, and occasionally act as data verifiers • Data is primarily used to further develop an understanding of the natural world, and to build disciplinary cannons of knowledge, with long-term intentions to inform policy development, applied resource management and conservation strategies • Data sets are most often regional, extending to global • Data is often shared with the biodiversity management arm of government
Citizen Science for Policy & Management of Natural Resources	• Collection of national biodiversity data sets • Scientists lead projects, most often from within government organisations, and in partnerships with a range of civic partners • Citizens contribute data, and occasionally act as data verifiers • Data is primarily used to inform national policy and institutionalised management of natural resources, and to contribute to international policy and conventions • Data is collected at national scales, and divided across biomes within the national set • Data is sometimes shared with other citizen science projects and research programmes
Citizen Science for Applied Conservation Action	• Collection of focused data sets (species / area / human-wildlife interactions) • Projects are most often co-constructed, and led by scientists acting as citizens, often based within NGOs and other civic organisations • Citizens collect, analyse and intervene into context informed by data • Data is primarily used to inform applied conservation actions in response to already evident risks (and sometimes to inform national policy and international regulation) • Data is collected across scales, including local, national, regional and international scales.
Citizen Science for Ecosystem & Earth System Monitoring	• Collection of focused data sets within a specific ecosystem (for example, a water catchment) or in relation to a specific aspect of the Earth System (such as climate change) • Projects can be located in a range of institutions, often involving multiple institutional partners • Scientists design inquiry tools and citizens contribute an understanding of context and contextual practices (projects transcend institutions and communities) • Citizens work with scientists, educators or extension workers to collect, analyse and interpret data, and potentially take actions informed by findings • Data is primarily used to build common knowledge intended to support the development of civic action towards the co-management of an ecosystem or particular aspect of the Earth System, among diverse stakeholders and interest groups • Data is collected within a focused area, ecosystem, or aspect of the Earth System

Purpose of Citizen Science Project	Shared Tendencies Among Citizen Science Projects
Citizen Science for Community Action-Taking, Activism & learning	• Collection of focused data around a particular issue related to a specific context (for example, pollution impacting on a particular neighbourhood) • Projects are initiated from within communities, and are not usually located in any particular institution, but rather arise through community collectives; institutional partners may join the project at later dates • Citizens and scientists work together to develop inquiry-led tools to gather 'evidence', and analyse data collaboratively; data is used to inform collective and individual actions • <i>Data is primarily used as a tool to strengthen activism and lobbying, and to challenge mainstream practices or bylaws, as well as to build common knowledge about a situated risk among a group of citizens</i> • Data is collected around a specific issue within a particular context
Citizen Science for Situated & Wider Social Learning	• Scientists work with, or as, educators to design inquiry tools and citizens contribute an understanding of situated risks and contextual practices • Projects are located in a range of diverse institutions and often related to broader programmes • Citizens work with scientists, educators or extension workers to collect, analyse and interpret data • <i>Scientific inquiry is primarily used as a tool for learning, to develop a 'cultivated scientific gaze' which it is hoped, will inform inquiry-led contextual action in response to current and future social-ecological risks</i>

* a previous version of this table appeared in Vallabh (2017) - see Appendix 7

6.9. Knowledge Mobilisation in Response to Social-Ecological Risk

All the mapped projects had clear purposes which were generally related to the collection of particular forms of scientific data or, in the case of school-oriented projects, the development of scientific literacy through working with data. However, projects use of data was also noticeably socially embedded, and generated in response to specific aspects of social-ecological risk (for example, biodiversity loss, ecosystem destabilisation or poor water supply), rather than from a straight forward intention to inform scientific research. In the following section, I consider epistemic cultures in terms of their processes of knowledge production in response to risk, drawing on Latour's notions of 'matters of fact' and 'matters of concern' (Latour, 2004). As presented in 2.7, Latour's distinction between the production of matters of *fact* or *concern* is related to how knowledge is produced, and whether the ontological politics of knowledge production remain visible in knowledge produced, rather than whether the knowledge

produced is intended to respond to risky matters or not (*ibid*). Drawing on the analysis above, I consider whether each of the approaches to citizen science mapped above are more strongly engaged in the production of 'matters of fact' or 'matters of concern', using project purposes to distinguish between approaches.

6.9.1. Knowledge Mobilisation in Species Mapping Approaches

Within these approaches to citizen science, citizen scientists are most often naturalists or hobbyists who aspire to contribute to the conservation of particular species and the common good by helping to build scientific datasets, which were eventually used to inform policy and applied conservation. This group also contains groupings of citizens with little or no interest in building common knowledge, and whose participation might be described as recreational in nature - they wish to experience and enjoy the natural world, and a particular citizen science project offers the opportunity to do so. Here, risk is more often perceived as abstract, generic, and universal in scale, rather than directly and immediately experienced. Knowledge production is along formalised and established systems, with responsibility for meaning-making conferred on professionals appointed to these roles. Epistemic role distinctions are naturalised, and epistemic objects are intended to enhance neutrality and generate comparable data.

Projects are most strongly oriented to the production of 'matters of fact', in that the entire system of production, from data contributors through to eventual producers, become invisible in the eventual knowledge produced - epistemic cultures result in the production of facts which stand alone as established and (mostly) certain. Epistemic outcomes are generally described in two ways - first in terms of the immediate production of a particular form of factual knowledge (a species distribution map, or species counts, for example), and second, in terms of anticipated, eventual application of such knowledge into biodiversity management strategies at an uncertain point in the future, through uncertain implementation mechanisms. There is a clear distinction between processes of knowledge production (and the epistemic subjects engaged in this task), and knowledge application into the world. The knowledge is produced and passed along in the form of field guides, academic papers and species atlases. There are established processes in place to facilitate the transfer of produced knowledge from one epistemic institution (most often academic) to another (in the case of research clusters like the ADU, transfer occurs between the university where the unit is located and the national biodiversity management institute).

Knowledge produced in this way is legitimated by established scientific processes, and validated across recognised and established knowledge cultures that span knowledge production and knowledge translation organisations.

6.9.2. Knowledge Mobilisation in Policy and Resource Management Approaches

As with species mapping approaches, citizen scientists within policy and resource management approaches are most often naturalist or hobbyists connected with various civic organisations or membership clubs. There is a more immediate relationship between knowledge contributions and intervention into the real world because of the institutional arrangements managing the projects, therefore, there is a stronger interest in building common knowledge that will perceivably be translated into real-world interventions.

Risk is engaged with in multiple ways within these approaches, reflecting risk orientations between the different organising partners. From a national resource management perspective, risk is framed in terms of existing policies and their accompanying mandates; institutional mandates determine what counts as risk and which forms of risk are prioritised within which regions, as which forms of knowledge production are appropriate in response to perceived risks. Risks are perceived both at more abstract and generic levels across macro-geographical scales, as well as in relation to specific, especially risky contexts such as threatened ecosystems or threatened species. Simultaneously, risk is also perceived as situated within specific contexts, and is understood as such through the situatedness of civic organisations and membership groups who bring with them a contextual knowledge of risk. While formal processes of knowledge production tend to be hegemonic in nature, with a focus on building universalised forms of scientific knowledge, enacted through State systems, parallel processes of expansive, situated learning occur through informal or unofficial epistemic processes or applied conservation actions which fall outside of the official institutional mandates of State organisations. As evidenced in the *CREW* and *ToadNUTS* case studies in Chapter 7, there is some indication that official aspects of epistemic cultures sometimes expand to include and integrate this latter form of situated risk-responsiveness.

Projects tend, officially, to be more strongly oriented to the production of 'matters of fact', with an often unofficial tendency to expand into the generation of 'matters of concern' within *specific*

contexts of situated risk - the same knowledge is mobilised within both approaches. There is also a more immediate relationship between the production and application of 'matters of fact', because it is being generated within the very institutions mandated for policy development and applied management. Fewer knowledge translation processes are required because the epistemic architecture of knowledge production is already aligned with State mandate, and pre-designed to meet the knowledge needs of established systems of governance.

6.9.3. Knowledge Mobilisation in Applied Conservation Approaches

Applied conservation approaches tend to draw citizens from a range of contexts, and especially from within contexts of situated risks. Citizen scientists are often specifically recruited in response to such risks, and form part of the membership of the organisation in which projects are located. Citizen scientists are also recruited among private landowners and other institutional partners across contexts of risk (EWT's projects are good examples of this). Although many citizen scientists in this grouping participate with a specific intention to mitigate a particular social-ecological risk (such as reducing the amount of roadkill), their number also includes hobbyists and biodiversity enthusiasts. Data sets are used to inform short, medium and long-term applied conservation interventions, and citizen scientists often have the option to become directly involved in the implementation of such interventions.

Here, risk is perceived as specific and situated, as well as implicated in systems of activity. The epistemic interest is in building and mobilising knowledge in response to perceived risk, with a strong intention towards intervention. Although the epistemic system is in many ways still connected with hegemonic scientific systems knowledge production, the primary focus is on building common knowledge that can be rapidly mobilised to mitigate risk. As such, the forms of knowledge production include both scientifically legitimated forms such as peer-reviewed articles, as well as knowledge translated into publicly accessible formats that members have access to. Knowledge is often mobilised before it has undergone lengthy processes of scientific knowledge legitimation. Projects appear to engage in both 'matters of fact' as well as 'matters of concern', and there is a specific form of epistemic currency afforded to knowledge producers who are able to successfully leverage knowledge in response to situated risks. The two approaches to knowledge production are often engaged concurrently within different but interconnected systems of activity.

6.9.4. Knowledge Mobilisation in Ecosystem and Earth System Monitoring

Approaches

Within these approaches, citizen scientists tend to be members of a geographical community who have a direct relationship with the ecosystem, or are being affected by an at risk aspect of the Earth System (for example, communities within a particular water catchment, or those experiencing particular climate change impacts within a region). They are often recruited from a range of smaller communities, industries and land-use practices, all of which are affected by, and impacting a specific ecosystem or aspect of the Earth System. Citizen scientists are recruited to build collective knowledge towards relational forms of agency, and do not necessarily share the same knowledge production or intervention goals.

Here, risk is already perceived as manifest, and epistemic cultures are geared towards commoning as a form of alliance-building and participatory response to situated risks; one of the roles of knowledge production is to support resident communities to perceive risk in particular ways. Risks are specific and local. Forms of knowledge production tend to include both universal forms of knowledge production (such as using standardised water testing standards), as well as situated, in that such knowledge is intended to inform project participants about the state of their specific environment. Projects sometimes include expanded systems of activity geared towards supporting project participants to translate findings into applied actions, or at least to support the applied actions identified and promoted by organising partners. Once again, there is a tendency towards expansive systems of epistemic activity, where different partners in a project mobilised knowledge in ways that related directly to those risks most perceived by them. As such, there is a distribution of epistemic activity between producing 'matters of fact' (led by academic partners, State partners, and civic partners with strong scientific orientations), and generating 'matters of concern', evident in emergent, risk-responsive strategies which might be informed by facts produced, but are not constrained by formalised knowledge production systems. Ontological politics are often (although by no means, always) made evident as part of knowledge production processes. Knowledge production processes are more likely to be negotiated between various stakeholders and project participants, as are situated interventions.

6.9.5. Knowledge Mobilisation in Community Action-Taking, Activism and Learning Approaches

In these approaches, citizen scientists (including scientists who are also citizens of a particular community) are often self-mobilised and organised, and sometimes form alliances with other institutional partners (often partners who are able to leverage scientific or political skills in service to the project). Citizen scientists are located within particular contexts of already manifest and situated risk. Distinctions between epistemic roles, and various forms of epistemic and political authority are challenged, and counter-cultural arrangements are actively sought as part of project implementation, and increasing citizen scientists' epistemic access often forms a key component of project activities.

Risk is perceived as immediate, with responses to risk urgently sought - the focus is on intervention, with knowledge production perceived as a means towards this end, rather than a goal in itself. These projects rarely report on knowledge produced within scientifically legitimated spaces, except where such reporting provides political advantage in addressing risk, or where a scientist-collaborator produces this form of knowledge on behalf of the project. Knowledge production is most strongly oriented towards the generation of 'matters of concern', and any knowledge produced in relation to the situated risk maintains evidence of its ontological politics (see 4.4). The visibility of ontological politics is even considered beneficial to risk responsiveness in many instances, with citizen scientists working to make visible the ontological politics of opposing parties and their knowledges. Definitions of risk and systemic understanding of the causal systems generating risks are expansive, messy and complex, and knowledge produced maintains its connection to such messiness. Interestingly, scientists are often recruited to support the translation of 'matters of concern' into 'matters of fact', in the face of institutions which are primarily geared towards working with factual knowledge forms (this process of translating concern into fact is illustrated in the case study on *Khulumani Water for Dignity*, in Chapter 7).

Scientific data were collected primarily as a way of evidencing situated experiences, and to provide systematic counter-evidence which hopefully challenged established practices, and provided grounds to advocate for change as a matter of urgency. Citizen scientists often wish to be identified with, and acknowledged as the knowers of knowledge produced (in contrast to

earlier approaches, where citizen scientists are socially acknowledged, but epistemically anonymous). Knowledge is legitimated in terms of its ability to enable intervention into context, rather than for any particular form of scientific coherence, *per se*.

6.9.6. Knowledge Mobilisation in Situated and Wider Social Learning

Approaches

There are two approaches evident in this category of citizen science, perhaps best perceived as two ends of a continuum of practices, with most projects falling somewhere between the two.

In the first, citizen scientists were most often recruited in relation to future risks, or future ability to respond to risk. Epistemic activities were geared towards supporting learners to develop a 'cultivated gaze' or way of perceiving and investigating risks. The development of scientific literacies often formed a large part of project activities, with an intention to help learners to learn how to produce knowledge, rather than the production of specific knowledge itself. School-based programmes provide a useful illustration of this. Such approaches were also perceived as a mechanism to structurally integrate particular knowledge production approaches into the social fabric of society. Learners were supported to translate scientifically informed findings into situated interventions, but these goals were secondary to learning goals. This grouping of projects prioritised the development of scientific literacy over intervention. While risks might be perceived as immediate (depending on the project focus area), translation of knowledge in response to risks were located in an unspecified future. Knowledge production remained within universal terms, even as such knowledge was built within specific contexts. Additionally, knowledge was shaped and constrained by structural priorities, manifest within formal school curricula, which directed the forms and foci of scientific literacy development. However, many projects simultaneously used such learning processes to raise awareness and develop knowledge in relation to specific risks. For example, the scientific method was used to collect data about water quality, and as part of the learning process, learners were taught about how the data collected, translated into river health status within a local context, and expanded into learning about the potential causes of risk. Depending on the project focus area, learners were engaged in the production of both 'matters of fact', and 'matters of concern'.

In the second group, social learning was perceived as a way to build necessary skills which supported intervention in response to immediate and already manifest risks. Here, learning mediated the translation of knowledge into intervention, in addition to facilitating processes of knowledge production itself. Knowledge production was not limited to scientific knowledge, and the focus was on learning about a local environment, and social-ecological relations within that environment, rather than the production of scientific knowledge itself.

6.10. Between Fact and Concern: Epistemic Tendencies

The distinctions between epistemic cultures geared towards the production of 'matters of fact' and those generating 'matters of concern' can be elusive, and strong claims about knowledge production practices become precarious in light of the expansive tendencies of such epistemic cultures. Partially, this is because there are a number of salvation narratives which portray citizen science as a mechanism for recruiting citizen scientists in the establishment of scientific facts, which will hopefully influence them to respond to pressing concerns, rather than being recognised as a form of knowledge which can be mobilised in a variety of ways in the service of communities who are engaging with social-ecological risks in diverse ways. Many of the critiques leveraged against citizen science as a legitimate domain of knowledge production do so on the basis of the production of 'matters of fact', without considering their unarguable suitability towards the generation of 'matters of concern'. When considering the epistemic cultures of citizen science projects, it is useful to recognise that different approaches work between the production of fact and concern in diverse ways, making them more or less suitable towards the production of particular forms of knowledge. Latour's distinction between the two processes of knowledge production provide a useful way to more meaningfully distinguish between these approaches, and to recognise the relationships between the ways knowledge is able to be mobilised and systems of knowledge production.

Recognising the range of mobilisation strategies evident in different approaches to citizen science provides insight into which approaches might be better geared towards particular temporal, geographic, and political responses to risks. It also lays the groundwork for recognising deep epistemic, contributory, and distributive injustices within cultures which foreground the production of 'matters of fact', even as such cultures work towards the common

good, albeit within more strongly hegemonic terms. In light of this discussion, it might be more appropriate to ask:

Which forms of knowledge production is an approach to citizen science best suited for, rather than whether citizen science (as an entire domain of diverse practices) is a legitimate field of knowledge production. Table 10 below summarises the orientation of particular epistemic features, in relation to the two forms of knowledge production (fact or concern), and provides an initial guide towards designing citizen science projects with particular intentions of responding to wicked social-ecological risks.

Table 10: Epistemic features in relation to the production of matters of fact or concern

	Producing Matters of Fact	Generating Matters of Concern
Epistemic purposes	Knowledge-building towards a specific pre-determined scientific knowledge production objective	Collaborative knowledge production towards an open-ended, complex and shared 'matter of concern', which may manifest differently in diverse contexts and for different epistemic subjects within the same contexts.
Epistemic subjects	Collective action is directed by one particular form of professional, scientific expertise for scientifically legitimated epistemic activities. However, there is evidence to indicate that informal systems of relational expertise outside of legitimated epistemic activities result in various unexpected and unofficial forms of collective activity and intervention within volunteer contexts. Sometimes, this activity becomes legitimated through mechanisms such as scientific publication or by being adopted into systems of legitimated activity. There is limited opportunity for agents to enact their agency here, beyond what Emirbayer and Mische (1998) categorise as an iterational dimension, where agents reactivate past patterns which are framed within scientific protocols. Although there are forms of relational expertise evident within these epistemic cultures, they are under-developed and highly constrained by existing hegemonic structures, roles and epistemic purposes.	Collective action is at least somewhat negotiated, and 'matters of concern' are co-defined from a range of perspectives. Opportunities to enact agency are fostered, and enabled within epistemic arrangements. Epistemic subjects more often engage in relational expertise and, sometimes, relational agency leading to new forms of collective action. Who the experts are might shift between subjects, depending on a particular context of activity (e.g. educational activity vs scientific activity, or local monitoring vs political representation).

Epistemic subjects (cont.)	The epistemic culture is structured to enable larger degrees of individual agency for particular individuals (those with more privileged epistemic roles and functions), rather than relational forms of agency.	A range of possibilities for expressing relational agency are possible within these cultures.
Epistemic objects	Epistemic objects are focused on mediating activity towards a specific scientific knowledge production objective, and constrain what counts as a legitimate knowledge contribution, and how such contributions are enabled. Epistemic objects need to hold in place legitimate scientific protocols, and are designed as mechanisms for strengthening scientific forms of rigour.	Epistemic objects are generative in nature, and aimed at opening up epistemic possibilities in response to a shared 'matter of concern'. They enlarge knowledge generation possibilities, in addition to facilitating the collection of systematic data. Epistemic objects need to facilitate boundary-crossing, negotiation and possibilities with working with different forms of knowledge towards a shared or overlapping epistemic goal. They engage a range of legitimation processes, including (but not limited to) scientific forms of legitimation.
Epistemic practices & processes	Epistemic practices and processes are geared towards establishing particular forms of knowledge production by leveraging and mobilising the time of a range of epistemic subjects towards a single scientific knowledge production objective. Epistemic activities are intended to facilitate coherent mobilisation of epistemic subjects towards specific forms of activity which best support legitimate knowledge-building processes, mediated through specific, pre-designed and legitimated scientific protocols. Knowledge-building activities are separated out from social interactions or reflections by any epistemic subjects not legitimated for these epistemic roles. Social interactions and reflections fall outside of legitimated knowledge production processes.	Epistemic practices and processes are geared towards mediating development of common knowledge at the boundaries of different epistemic, social and material contexts, and leveraged towards complex and varied responses to 'matters of concern'. Epistemic activities are aimed at both introducing new knowledge into an epistemic system, and mediating and opening up opportunities for critical reflection in response to iterative sequences of new knowledge (scientific and other). Knowledge-building activities encompass social interactions and reflection as vital epistemic activities - while different subjects might engage in epistemic activities at different times, legitimation of knowledge-building includes successful reflective and reflexive activity across the epistemic culture.

Epistemic outcomes	Epistemic outcomes are geared towards establishing legitimated 'matters of scientific fact' which contribute to a canon of universalised knowledge, that is divested of its contexts of production. Knowledge produced must be translated into systems of application.	Epistemic outcomes are aimed at generating relational knowledge that informs responsiveness to 'matters of concern', as well as building common knowledge which may be either contextual and specific or universal in nature. Knowledge produced is usable in the short-term, in responds to localised, situated risks.

6.11. Reflection on the Epistemic Mapping Process

In retrospect, while this mapping process undoubtedly provided a layer of insight into the epistemic cultures of citizen science projects in South Africa, there is much I would have changed if possible.

The mapping tool contained many list-selection questions, where project managers selected relevant categories from a pre-constructed list of options which were informed by an early literature review. Chapters 5 and 7 highlight the limitation of this approach, and make clear a need to update the mapping tool to take account of the following aspects of epistemic cultures:

- Consideration of a wider scope of potential epistemic purposes, including building knowledge structures and skills, targeted risk response (not only as a civic action), etc.;
- Articulation of knowledge forms beyond scientific knowledges;
- More nuanced articulation of epistemic roles and relationships, allowing for multiple subject-knowledge-outcome relationships between different epistemic subjects within the same project; and
- More careful articulation of epistemic foci on 'matters of fact' or 'matters of concern', and where in the knowledge production process these aspects are visible.

Administering the mapping tool via interview provided invaluable insight into the epistemic cultures of projects, adding depth and insight into the responses captured in the mapping tool. A stronger integration of interview data would greatly enhance mapping processes in future.

6.12. Conclusion

Based on the analysis in this chapter, it is evident that this landscape of epistemic activity should be referred to as the citizen sciences (plural), rather than citizen science (singular). There are distinct groupings of epistemic cultures, related to which knowledge is being produced, by

whom, and towards which epistemic outcomes. These cultures appear to be sufficiently distinct from each other to be recognised as a differentiated landscape of epistemic practices. While each of the projects mapped built and mobilised scientific knowledges, they did so in often substantially different ways, with diverse intentions. The processes of knowledge were likewise distinct, as was their orientation to social-ecological risk.

A key outcome of the development of a refined heuristic was that it provided a relational representation of epistemic features, and enabled a stronger relational articulation of knowledge production within diverse epistemic cultures. The relational articulation of epistemic cultures enables a stronger and more coherent perspective on how knowledge production and learning might be expanded to strengthen epistemic access or deepen epistemic, contributive and distributive justices, for example (see 1.3). It enabled the perception and articulation of shared tendencies among similar approaches to citizen science. It also provided insight into which approaches to citizen science might best be suited for particular types of knowledge production, depending on a more refined articulation of the desired epistemic outcomes. This includes preferred orientations towards the production of 'matters of fact' or 'matters of concern'.

In the context of this study, social-cultural mapping has been used as a tool to make visible, and thereby gaze across a range of citizen science practices (and across a range of *different* contexts), while hopefully avoiding conflating and homogenising a highly individualised and dynamic arena of practices. It enables a variety of opportunities to cluster and group projects based on overlapping epistemic practices and project design features, without placing them into fixed boxes that obscure the unique features of each. Hopefully, this approach provided a stronger focus on relational features of diverse groupings of citizen science practice, rather than consigning them to definitive and discrete designations and categories of practice.

In the next chapter, I consider the epistemic cultures of three of the mapped projects in more detail, this time through an analysis geared to make visible, sociologies of absences and emergences. This analysis enables the recognition of forms of knowledge production other than (and also including), scientific forms. The analysis is intended to provide a deeper layer of insight into the epistemic cultures of the citizen sciences.

CHAPTER 7

(Re)stor(y)ing Through Sociologies of Emergences

7.1. Introduction

Perhaps we will need to know them through the hungers, tastes, discomforts, or pains of our bodies. These would be forms of knowing as embodiment. Perhaps we will need to know them through 'private' emotions that open us to worlds of sensibilities, passions, intuitions, fears and betrayals. These would be forms of knowing as emotionality or apprehension. Perhaps we will need to rethink our ideas about clarity and rigour, and find ways of knowing the indistinct and the slippery without trying to grasp and hold them tight. Here knowing would become possible through techniques of deliberate imprecision. Perhaps we will need to rethink how far whatever it is that we know travels and whether it still makes sense in other locations, and if so how. This would be knowing as situated inquiry. Almost certainly we will need to think hard about our relations with whatever it is we know, and ask how far the process of knowing it also brings it into being (Law, 2004:3).

In Chapters 3 and 5, I used sociologies of absences to provide a second reading of three aspects of the general knowledge cultures within which citizen science projects are enacted (Chapter 3), and peer-reviewed citizen science literature (Chapter 5). In this chapter, I further analyse projects in the field through a 'sociology of emergences' (Santos, 2004). This sociology of emergences provides a framework to consider how knowledge, learning and action are actualised within different epistemic cultures. The analysis here is primarily focused on ecologies of knowledges, with minimal attention offered to the other four ecologies (temporalities, recognitions, trans-scales and productivities) articulated by Santos (2004).

The chapter provides a generous reading of knowledges and their interactions - in other words, although it allows for and occasionally articulates the critiques framed in the first four chapters, it also engages in what might be termed a benevolent or broadly tolerant reading of data to illustrate the possibilities of ecologies of knowledges within three examples of practice¹¹⁷. In the chapter, I engage with the most easily visible and illustratable knowledges within the data sources available; I also recognise that there will be other knowledge forms implicated in the epistemic cultures emerging here - those which are not understandable to me through my personal experience of knowledges, and those that have not been captured in recognisable forms within the data sources accessed.

I present three illustrative case studies from the South African field of citizen science practice. Between them, the case studies illustrate a range of ecologies of knowledges being leveraged by projects in order to both build common knowledge and also to take action informed by such

¹¹⁷ An initial version of this chapter was published as: Vallabh, P. (2017). Transforming epistemic cultures in ESE with citizen and civic sciences as means for reframing participation in the commons. Envisioning futures for environmental and sustainability education, 87 (see Appendix 7)

knowledge. The cases were selected because they provide insight into diverse arrangements of knowledges within unique organisational arrangements. As noted in 4.2.4.3, the cases are neither representative nor selected as any form of ideal or best practice; instead they provide a window into how ecologies of knowledges might, and do, seem to emerge within citizen science approaches to knowledge production.

My approach is to evidence various forms of knowledges; the evidence is limited to articulations or attempted articulations of diverse knowledges by project participants through project reports, papers and newsletters. My intention is not to make definitive claims about the ecologies I describe, but rather to demonstrate why such articulations bear further consideration, and how they might be useful for strengthening or enhancing the epistemic cultures of citizen science projects. The chapter also speaks strongly to epistemic, contributory and distributive justices and participatory and radical democracy imperatives outlined in Chapters 1, 3 and 4.

7.1.1. The Three Case Studies:

- Illustrative Case 1: Custodians of Rare and Endangered Wildflowers (CREW) is a collaborative project between the South African National Biodiversity Institute (a State parastatal), and Botanical Society of South Africa (BotSoc - a biodiversity NGO).
- Illustrative Case 2: Khulumani Water for Dignity (WfD) narrates the collaboration between a civil society activist group, a team of Rhodes University researchers, and Khulumani (civil rights NGO).
- Illustrative Case 3: ToadNUTS is a community-initiated project, which collaborates with a range of partners and stakeholders, including the City of Cape Town municipality and various biodiversity parastatals and scientific institutions.

7.1.2. Ecologies of Knowledges

Building on the descriptions of epistemic cultures within the citizen sciences presented in Chapter 6, it is also possible to begin to reflect on these processes from the perspective of a mobilisation of 'ecologies of knowledges', which provides a second layer of description of the epistemic cultures of citizen science practice and their resultant potential for knowledge co-production, learning and risk-responsive action. Three of the features of these ecologies of knowledges are that:

- They draw on multiple forms of knowing and knowledge;
- Different knowledges are brought to the fore at different times in the process; and
- These knowledges work together to make objects visible in new, contextually responsive ways.

This informs the way in which citizens and scientists (and scientists enacting citizenship) are able to use knowledge produced in citizen science projects to respond to situated risks. The three cases studies provide more detailed examples to illustrate how these ecologies of knowledges are being mobilised. A more detailed orientation to the concept and theory of ecologies of knowledges is presented in 2.11. Ecologies of knowledges seek to make visible those epistemologies which might have been produced as nonexistent, and to reclaim wasted social experience by doing so.

7.1.3. Recognising Uneven Starting Points

As argued in Chapters 2 and 3, particular forms of knowledge have been rendered legitimate, while others are proclaimed illegitimate. In writing this chapter, I recognise that many of the forms of knowledge I attempt to draw into visibility do not yet have robust internal systems of rigour and legitimation, and many more have internal systems of rigour not visible within scientific canons of knowledge and systems of knowledge production; nor do I attempt to develop or argue for their rigour here. Instead, I intend simply to begin to notice indications of their existence, and to support thinking around how we might start to value such knowledges, and possibly effect systems of legitimation and mechanisms to enhance rigour (see broader argument in Appendix 11). Nor are the knowledge descriptions I use definitive and concrete; instead I suggest broad descriptions of knowledge types - I deliberately refer to these knowledges in the plural, recognising that such knowledge types might have a range of particular manifestations which require more in-depth research and theorising to become robustly formulated.

It is useful to remember at this juncture, that many of these knowledge forms of knowledge have been systematically delegitimated in multiple ways (see Chapter 3 for detailed sociologies of absences). They are not on an even footing with scientific forms of knowledge production in that they have not enjoyed the resources and epistemological attention that the western sciences have enjoyed. This places them at a disadvantage in terms of easily recognisable

systems of warranting and legitimation. Figure 33 below summaries a range of knowledge categories emerging through the analysis in this sociology of absences.

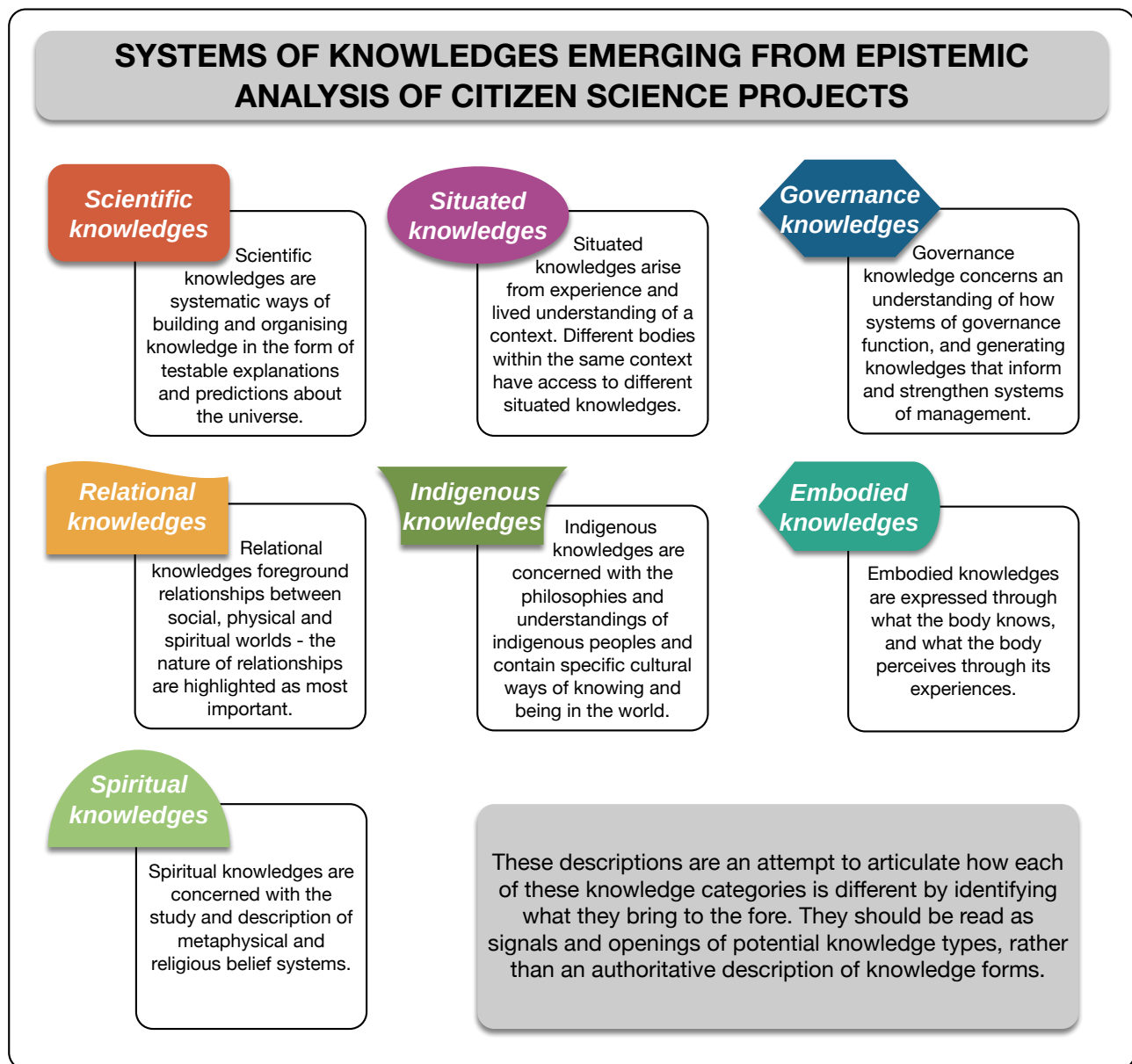


Figure 33: Knowledge categories emerging through the sociology of emergences of three citizen science projects.

There is already a body of literature offering some conceptualisation and theorisation of these knowledge types. I have not drawn specifically on any of these theorisations; however my thinking about them has been influenced to some degree by such authors as are noted below. Insights from the field of practice in which I am immersed have played a greater role in expanding my understanding of what counts as knowledge, and who might be considered as legitimate epistemic subjects.

I have considered the formulation of scientific knowledges in Chapters 2 and 3 - the cannon of work articulating scientific knowledges is, self-evidently, the largest of the knowledges included here, and in itself, a plurality of knowledges. Concepts of governance knowledges have been informed by the work of Foucault (1991) and the critique on science and its publics presented in Chapters 1 and 3. Notions of situated knowledges arise most strongly from the research community I am part of, as well as drawing on the work of Haraway (1989, 1988), Braidotti (2019, 2011), and the critique of Anthropocentric knowledge construction offered in Chapter 3. Conceptions of embodied knowledges are influenced by the works of Gendlin (1992), Haraway (1989, 1988), Braidotti (2019, 2011), Dei (2010, and through him Fanon), the work of my colleague Injairu Kulundu-Bolus (2020), as well as work on a collective project on citizen sciences and water quality monitoring (see Appendices 9 & 10). The unsatisfactorily broad notions of indigenous knowledges, once again, emerge through the works of various colleagues within my research community, as well as through the work of my colleague in indigenous studies, Brigitte Evering, and scholars such as Turnbull (2009), Agrawal (2014), Hoppers (2009, 2002), Verran, (1998). My understanding of relational knowledges has emerged relationally, beyond any one theorist, but drawing most strongly on indigenous knowledges scholarship.

Before we can begin the process of distinguishing the substantive differences between knowledges, or articulating their bases of legitimation, we must first find the trails, hints, stories, and utterances which point to the existence of such knowledges. This is the work I undertake in this Chapter - I evidence the existence of such knowledges in preparation for the more substantive tasks of investigating their substance in future research.

7.2. Illustrative Case Study 1: Custodians of Rare and Endangered Wildflowers (C.R.E.W)

The *Custodians of Rare and Endangered Wildflowers (CREW)* Programme is a citizen science programme focused on monitoring and conservation of rare and threatened wild plants. It was formed through a partnership¹¹⁸ between the South African National Biodiversity Institute (SANBI) and the Botanical Society of southern Africa (BotSoc), with an institutional home in SANBI and a programme home within SANBI's *Threatened Species Programme*. The project is

¹¹⁸ The programme has a range of partners, not all of whom have been detailed in this case report. The Mapula Trust is one of significance for the Cape Floristic Region Node because of their catalytic contribution to starting the project. The Trust is still an active funder of the programme.

Key findings:

- The programme is effectively aligned with relevant components of SANBI's mandate. Strong alignment has been achieved with relevant core components of South Africa's (National) Plant Conservation Strategy (NSPC)[sic], contributing to 9 of the 16 targets, and SANBI's Corporate Strategic Plan 2015-2020.
- Clear alignment has been attained with the constitutional mandate, objects and associated core activities of the Botanical Society of South Africa (BotSoc). CREW is highly synergistic with BotSoc's current and proposed future focus areas, including effective and practical BotSoc member participation in plant conservation. ...
- CREW has leveraged the collection of accurate, reliable and recent plant species data totalling 100,570 records for 8,973 plants (44% of the flora), with data collected for 2,120 threatened and rare plants since 2003. Plant data has been collected across vast geographical regions of South Africa and a highly diverse array of families and genera. A high frequency of targeted collection, high level of spatial accuracy, and high degree of sampling efficiency has been achieved across a vast array of botanical families. A total of 2,382 visits were undertaken to 58 under-sampled areas between 2003 and 2018.
- CREW has also provided a total of 19,437 additional new specimens to SANBI's Biosystematics Division to support the accurate and effective identification of species. Via CREW, the Biosystematics Division of SANBI has been able to describe 30 new plant species, including those under formal description at present. ... The programme has also supported the collection of seed for the Millennium Seed Bank (MSB) for a substantially greater number of species and geographic locations than if such collection had been undertaken solely via SANBI staff. A total of 138 species have been collected by volunteers since 2016. Of the 514 threatened species banked by MSB between 2005 and 2018, 35 (7% of these were collected by the CREW citizen science network.
- ... Over the course of the project 178,803 person hours had been donated to the programme through volunteer time ... In light of the vast geographical extent of the country, the immense diversity of South Africa's flora, and the depth of skills and experience needed to accurately identify species, which take an extensive period of time to acquire, the programme has delivered a very high return on investment.
- The data collected via the programme supports the effective annual updating of the Red List of South African Plants and updating of the National Biodiversity Assessment (NBA); updating of SANParks management plans, ongoing adaptive management, and World Heritage Site and Natural Wonders of the World reporting; Provincial Systematic Biodiversity Plans; National and Provincial Protected Areas Expansion Strategies; National and Provincial Biodiversity Stewardship programmes and local stewardship initiatives; District, Metropolitan and Local Systematic Biodiversity Plans, including biodiversity sector and bioregional plans; Environmental Impact Assessment (EIA) and Water Use License Application (WULA) processes; Spatial Development Frameworks; Environmental Management Frameworks; Strategic Environmental Assessments; Land Reform planning processes; Land Use Management decision making; and management of private land (e.g. grazing and burning regimes, amongst others.

(Stewart, 2019: iii-iv)

dual-funded through SANBI and BotSoc, with networks of partnerships across various national, provincial and local conservation bodies, a range of municipalities and civil society partnerships (including various private landowners with key threatened plant populations on their land) (Parbhoo, 2017). CREW was initiated in 2003, and in 2018 had scaled up to 35 formally organised nodes of activity (Parbhoo, 2018), in addition to participating in a number of annual or ad hoc events beyond formal node activities.

SANBI is a parastatal organisation whose institutional mandate includes centralised monitoring and reporting on the status of the country's biodiversity towards conservation, sustainability and equitable benefit-sharing (Young, 2010). The institutional mandate speaks to the National Environmental Management Act (NEMA) (Act 107 of 1998) and the National Environmental Management of Biodiversity Act (NEMBA) (Act 10 of 2004). Through their *Threatened Species Programme*, SANBI coordinates and promotes application of species information in all spheres of biodiversity conservation, including national and international conservation legislation and policy, conservation planning, protected area selection, protection of threatened habitats, ex situ species breeding programmes, and development of biodiversity management plans, (Young, 2010). Key amongst policy contributions and implementation is CREW's work on the National Strategy for Plant Conservation, which it both informs and implements in various ways (Mohan, 2019).

BotSoc is an NGO, established in 1913, whose members engage in the study, conservation, cultivation and wise use of indigenous flora and vegetation of southern Africa. The organisation has re-oriented in recent years towards a more conservation and action-focused approach; so they also aim to inform policy, contribute to applied conservation, offer direct support to the Department of Environmental Affairs (DEA), and collaborate with local and provincial government agencies and institutions responsible for biodiversity and conservation management. BotSoc actively supports CREW, the National Plant Strategy, and other strategic programmes, in addition to supporting career pathing through tertiary institutions, and contributing directly to the National Strategy for Plant Conservation (in partnership with CREW), (Parbhoo, 2017¹¹⁹).

119 Also see <https://botanicalsociety.org.za>

7.2.1. Scope of Activities

CREW mobilises (mainly) high-skill citizens to collect data about rare and endangered plants with the specific intention of informing policy, national biodiversity management and land-use. In 2019, there were over 1000 volunteers contributing to the programme. The programme includes a range of volunteers who can participate in various forms of activity (not all of which are involved in working with scientific data), including school children, university students, unemployed youth, retired individuals and working professionals, who might be active either independently or within formal groups; the majority of high-contribution volunteers are retired plant enthusiasts (CREW mapping data). Volunteers might be involved in one or many of the following activities, depending on their skill levels and knowledges: a) data collection; b) species sampling; c) herbarium specimen preparation; d) data digitalisation; e) analysis; f) scientific reporting; g) education; h) establishing partnerships; i) species relocation; j) site assessments and threat identification; k) contributing contextual knowledge of potential threats, developments and land-use patterns; l) assisting in facilitating stewardship programmes; m) supporting rehabilitation activities, (e.g., related to mining); n) mentoring new volunteers; and o) creating awareness-raising campaigns (Parbhoo, 2017). The Eastern Cape node in particular, is focused on establishing career pathways and supporting youth from disadvantaged backgrounds to experience, and hopefully develop an interest in botanically related careers.

Initial programme focus was on surveying plant species, adopting key sites for conservation, and working with landowners to conserve threatened species, in addition to demographic monitoring of threatened plant populations and awareness-raising programmes (Parbhoo, 2017; Young, 2010), but the range of activities involving volunteers increased as the project became more established across diverse spaces. Project activities can be broadly described in two categories: a) collection of national plant data (especially threatened plants), and b) application of plant data into international-through-local policy and practice contexts. Illustrations of how these two forms of activity translate into practice can be seen in the evidence tables below.

7.2.2. The Contribution of the CREW Programme

The following extracts from the CREW 2019 Newsletter (SANBI, 2019) and recent external project review (Stewart, 2019) highlight the substantial contribution of the CREW programme to scientific knowledge production and biodiversity management:

7.2.3. Articulating an Ecology of Knowledges Within the CREW Programme

A preliminary articulation of the ecology of knowledges observed within the CREW programme is presented below.

7.2.3.1. Scientific and governance knowledges

In this project, there is a strong interest in the collection of rigorous scientific data to build scientific knowledge about rare and threatened plant species. There is also an in-depth knowledge of government policy and biodiversity management practices – what we could call a form of governance knowledge or knowledge of the governmentality of the state (Foucault, 1991). For example, the programme designers have an understanding of how knowledge about rare plants needs to be collected and presented in order to be usable in the context of environmental impact assessments for land re-zoning applications, or for IUCN Red Data List entries. This governance knowledge of state functioning is brought into a relationship with a knowledge of rigorous scientific data collection, and together, shape which data is collected, where it is collected, and how it needs to be collected *to be effective for informing state functioning around biodiversity management*. Stewart (2019:9) summarises this process, noting that SANBI,

is mandated to provide knowledge and information, planning and policy advice, and to pilot best-practice management models in partnership with stakeholders to support the sustainable use of the country's biodiversity. Giving effect to this mandate, SANBI plays an important role in supporting the translation of science into policy.

The following extracts illustrate some of the ways in which these two forms of knowledges are brought into a relationship with each other in order to determine what counts as valid biodiversity knowledge in the context of State functioning.

Table 11: Illustrative evidence of relationships between governance and scientific knowledges

Science or governance aspect	Illustrative evidence	Analytical notes
Knowledge-building strategy to inform applied biodiversity management	<i>"We need to improve our knowledge of the status, distribution and threats of the SOCC [Species of Conservation Concern]. Systematically sampling areas of natural vegetation is the best method of collecting this information", (SANBI, 2019a:9).</i>	This extract illustrates the privileging of scientific knowledge for informing biodiversity governance related to SOCC.

Science or governance aspect	Illustrative evidence	Analytical notes
Scientific knowledges - species identification and building systemic knowledge	<i>"It will go beyond just plants ... like other species identification courses, herbarium techniques ... how do you press plants ... how do you send things through to the herbarium ... how do you collect things in the field", (Ebrahim, 2014).</i> <i>"Each of the three CREW nodes organises specific hands-on training that will better enable the citizen scientists to achieve the programme's objectives", (Parbhoo, 2018:16).</i>	Ebrahim is discussing the types of skills required to participate effectively in the programme in order to collect quality scientific data and specimens. Parbhoo describes a system for strengthening scientific skills amongst volunteers.
Central role of state policy and implementation mandates in informing and shaping CREW activities	<i>"CREW is aligned with and makes an important contribution towards South Africa's Plant Conservation Strategy, with the programme actively contributing to 9 of the 16 targets", (Mohan, 2019:8).</i> <i>"Although several targets are relevant to the CREW programme"s [sic] objectives, the most significant contribution is to Target 7 which advocates for at least 75% of known threatened plant species conserved in situ by 2020. The programme also plays a role in Target 3 - whereby information and research in the Karoo region is integrated into the strategy. Also, the past year saw the CREW programme adding value to Target 5 by identifying important areas for plant diversity to incorporate into conservation processes. The nature of the CREW programme inevitably contributes to Target 14 (the importance of plant diversity is incorporated into communication, education and public awareness programmes) and Target 15 (trained people working with appropriate facilities sufficient to meet national needs) of the strategy" (Parbhoo, 2017:11).</i>	This extract evidences the central directing role of national policy in shaping the work of CREW. The specific implementation contributions of CREW to diverse state mandates are summarised in this extract. A more detailed breakdown articulating CREW's implementation of different aspects of the National Strategy for Plant Conservation can be found in Mohan, (2019).
Application of monitoring data into applied management strategies	<i>"[Links with conservation agencies] ensure that plant monitoring data is used in the conservation plans, which prioritise biodiversity for input into the landuse decision-making processes and for protected area expansion", (SANBI, Raimondo, 2017:2).</i> <i>"The data assist the provincial agencies in identifying Critical Biodiversity Areas, which is taken into consideration during the land-use planning and decision-making process", (Parbhoo, 2018:17).</i>	Here, Raimondo and Parbhoo both illustrate pathways through which monitoring data is fed into the governance system (also see Young, 2010).
Contributing to international governance systems	<i>"Our focus for 2016 has been to survey species listed as a priority by the Red List Team" ... "Efforts to increase data for the species would better enable the Red List team in providing good quality data for conservation plans and other land use decision products", (Parbhoo, 2017:6).</i>	Such text indicates intentional and purposeful scientific contributions to the international Red Data List (critically endangered, endangered and vulnerable statuses), and status reassessment processes, as well as articulating one aspect of the relationship between the scientific common knowledge being build and how such knowledge resources are intended to inform applied biodiversity management practices (also see Young, 2010).

Science or governance aspect	Illustrative evidence	Analytical notes
Overlapping state mandates inform data collection foci	<i>"This project [Critical Habitats Project] focussed CREW's attention on the species that are in most urgent need of monitoring" ... "many of these sites has [sic] already been identified as priority areas to be included in the protected areas network and this will happen through the Stewardship programme and the National Protected Areas Expansion Strategy", (Mohan, 2019:11).</i>	This extract illustrates how overlapping state mandates direct and inform where plant monitoring data (scientific data) needs to be collected as well as how it will feed forward into applied governance systems.
Expanding monitoring capacity into applied conservation agencies	<i>"Trips to the Steenbras Nature Reserve and Hansse-Kop (Hottentots Holland Nature Reserve) yielded several observations of threatened species. On these trips we were accompanied by field rangers, who, with encouragement and training to use iSpot, may be able to make a valuable contribution towards data collection in the reserve", (SANBI, Lochner, 2017:30).</i> <i>"... the Eastern Cape node has designed and facilitated simple plant identification training courses to better equip the ECPTA employed reserve staff and improve the reserve's herbarium collections", (Parbhoo, 2017:15).</i>	Lochner and Parbhoo are both describing strengthening a potential area of plant monitoring within applied conservation settings. Monitoring data would both be more directly available to inform conservation management within particular reserves, as well as contribute to national and international plant monitoring systems and levels of governance. These extracts evidence the close relationship between applied management practices and how and why scientific knowledge is being built.
Scientific knowledges framing and structuring monitoring processes, which in turn, feed into scientific knowledge-building	<i>"And then the monitoring, where we do a combination of site assessments - we go out and see what's there and we have to record information about the area that we're in, and then also, we do some very detailed population-level monitoring, and that also takes training ... it's plot-based and we need to show them [volunteers] how to tag the plants and all that kind of thing", (Ebrahim, 2014).</i>	Ebrahim is describing the areas of competence volunteers require in order to effectively and rigorously engage in ongoing plant monitoring activities. This segment illustrates the standardised monitoring protocols within scientific forms of knowledge production in this field.
Scientific knowledges - technical skills required for building scientific knowledges	<i>"We do support services like how to work a GPS and how to map stuff on GoogleEarth and how to take good photos ...those are also enabling skills", (Ebrahim, 2014).</i>	Ebrahim is describing a selection of key technical skills required for building scientific knowledge within the programme. The tools described are themselves, based on scientific forms of reasoning and knowledge
Interaction between scientific knowledge-building and applied governance into biodiversity management	<i>"We try to empower people to engage in conservation activities ... so a lot of our volunteers - through the programme, they get involved in other environmental issues like EIA commenting and that kind of stuff ... so we try to situate them to get more involved in those conservation-related activities", (Ebrahim, 2014).</i>	Ebrahim is illustrating how volunteers who collect scientific data within the programme can then participate in Environmental Impact Assessments (EIAs) from scientifically informed perspectives, drawing on the data collected within their specific areas.
Interaction between scientific knowledge-building and applied governance	<i>"We visited two school conservancies" ... "We have made recommendations to these schools with regards to invasive alien plant management and look forward to working closer with them", (SANBI, Sutherland, 2017:40).</i>	Here, Sutherland provides a practical example of how volunteers draw on co-produced scientific knowledge to inform applied conservation actions within specific contexts.
Interaction between tribal authority and scientific knowledge-building processes	<i>"A visit to a rural area near Bushy Vales was not as productive in terms of plants, but equally rewarding in that the induna [tribal officer in the traditional authority structure] was enthusiastic about receiving input on managing the grassland sustainably", (SANBI, Grieve & Grieve, 2019b:35).</i>	Here Grieve and Grieve describe establishing a relationship with the tribal authority in an area. The relationship is geared towards making plant data available to inform biodiversity management in this area.

Science or governance aspect	Illustrative evidence	Analytical notes
Developing scientific protocols and practices	• “Always collect reproductive parts (flowers and/or fruit) to guarantee a positive identification • ... If you are collecting species where the entire plant is required to complete a specimen (e.g. neophytes) the rule is to collect three whole plants. Please only collect 1 plant for every 10 found. This will ensure that we don’t negatively impact the plant population”, (SANBI, 2019a:15).	Again, this extract from the draft operations manual for CREW citizen scientists evidences the operationalisation of scientific protocols - this time as concerns sampling and collection of specimens.
Informing urban planning and management	“Our project of monitoring threatened species in Somerset West public parks and interaction with the municipality about a mowing regime is still very much a work in progress. The effort bore fruit when <i>Ixia versicolor</i> (CR) flowered abundantly in ‘Onser Jan’ park this year. Education and community involvement will be crucial to success of this intervention”, (SANBI, Lochner, 2017:30). “[T]he eThekweni Municipality’s Environmental Department prioritised purchasing various biodiversity rich sites” ... “The species lists generated feed both into the CREW node as well as the municipality’s integrated development plans. The improved management of sites over the years is proof that citizen scientists have a big role to play within the local conservation agency, especially with the management of threatened species sites”, (Parbhoo, 2018:18).	Through this example, Lochner illustrates a successful uptake of monitoring data into an applied municipal context, and outlines the need to mobilise additional forms of knowledge and activity to sustain success in the future. Parbhoo’s example similarly illustrates an ongoing relationship between scientific data and applied biodiversity management at a local level. (*CR and EN in extracts refer to conservation status of particular plants - Critically Endangered, Endangered, Threatened, etc.)
Developing scientific protocols and practices	• “Collect specimens. Please refer to the specimen collecting protocol ... • Take photographs of plant species. Remember to include photos of the habitat of the species and front, side and bottom views of flowers ... • ... Ensure data form is properly filled in and that all fields are completed. • Press specimens (see specimen processing guidelines)”, (SANBI, 2019a:13).	This extract from the draft operations manual for CREW citizen scientists illustrates one articulation of scientific methodologies and protocols being implemented within the project.
Informing Environmental Impact Assessment	“Seventeen Limpopo CREW members visited the area after a request to comment on a granite mining application” ... “A full species list was sent to the landowners and recommendations against mining in the area were made. Ultimately the mining application was rejected by the provincial authorities and this site remains undisturbed” (SANBI, Egan, 2017:51).	Egan describes an environmental impact assessment process, where scientific knowledge (in the form of a site species list) was used to influence proposed mining.
Developing agreements and joint activities	“The eThekweni municipality is fortunate to have funds to secure various biodiversity rich sites for conservation. Increasingly, the CREW programme has been requested to undertake botanical site surveys in sites that have been burnt prior to a field season. Thus, the Durban CREW group in particular has become a valued asset to the municipality by making significant contribution to the municipality’s [sic] integrated development plan”, (Parbhoo, 2017:16).	Such references illustrate the role of CREW in developing agreements and joint activities between SANBI (as the institutional home of CREW) and local governance agencies or organisations. Another example is of grazing agreements being negotiated in the Ozabeni grasslands, for example (SANBI, 2017).

Science or governance aspect	Illustrative evidence	Analytical notes
Building focused scientific knowledges to inform national biodiversity management strategy	<i>"SANBI submitted an application to the Foundational Biodiversity Information Programme (FBIP) to fill biodiversity information gaps for 11 taxonomic groups to support development decision making the Karoo" ... "The CREW CFR team has been intimately involved in the fieldwork process" ... "The fieldwork will be carried out by sampling 60 (8x8km) pentads which have been statistically selected to represent all the different environments in the Karoo", (Parbhoo, 2017:11).</i>	This extract describes CREW involvement in the Karoo BioGaps Project, which aims to mobilise foundational biodiversity data for use in decision making and conservation planning (also see SANBI, 2017). It particularly evidences a process of building scientific knowledge with a targeted and specific purpose of informing a particular governance need.
Strengthening and verifying common knowledges being used to inform environmental impact assessments and state mandate for the Department of Environmental Affairs	<i>"Over the next field-seasons, CREW citizen scientists will be surveying these 'Lost species' in an effort to verify old data and offer an update to the status of these species. Ultimately, this data shall feed into land-use tools being developed by the Department of Environmental Affairs [DEA] to provide evidence of areas that are prohibited from development", (Parbhoo, 2017:12).</i>	This extract provides another example of the driving power of state mandate (in this case, common knowledge to inform development processes) in directing how and where scientific knowledge is being built. This process has become a strategy to inform the development of land-use screening tool for DEA, to form part of Environmental Impact Assessments nationally (SANBI, 2017).
Management of scientific data in terms of governance mandates and state obligations	<i>"Species of conservation concern data are highly sensitive as many of these species are either highly localised or are targeted directly for trade. SANBI's [sic] Threatened Species Programme obtains and manages the spatial occurrence data collected from data-partners who retain ownership of these data. In consideration of the complexity of the sensitive data, the Threatened Species Programme has endorsed 20 data sharing agreements with the provincial conservation agencies, a few municipalities, non-government organisations and biodiversity consultants", (Parbhoo, 2017:17).</i>	This quote demonstrates the management of scientific data in terms of state mandate.
Developing capacity for building scientific knowledge production towards state governance in the future	<i>"In response to plant conservation being a scarce skill, the CREW Programme has introduced the CREW Human Capital Development project which feeds into Objective statement 6.1: A transformed and suitably skilled workforce for the biodiversity sector is developed of [sic] SANBI's Annual Performance Plan 2018-2019" ... "This engagement is increasing the number of internship applications from students interested in plant conservation as well as an increase in the number of students participating in some CREW groups' fieldtrips", (Mohan, 2019:12).</i>	This extract indicates an intentional focus on developing a particular form of scientific knowledge related to a scarce skill required for effective biodiversity monitoring. Here we see how CREW contribute to SANBI's Human Capital Development project by engaging with tertiary students around career pathways and providing skills development and fieldwork support and opportunities (also see SANBI, 2017).
Feeding data into national level Strategic Environmental Assessments	<i>"Information gathered by CREW volunteers helps to prioritize the species that need conservation attention. The data collected are also used during the Environmental Impact Assessment (EIA) process to influence development decisions, as well as in fine-scale conservation plans that assist municipalities to determine which areas should be demarcated as conservation areas in their integrated and spatial development frameworks" (Young, 2010:17).</i>	Young articulates the relationship between two forms of governance and the scientific knowledge produced within CREW.

Science or governance aspect	Illustrative evidence	Analytical notes
Scientific skills development being leveraged towards applied biodiversity management	<i>"[C]itizen scientists are provided with educational benefits such as skills for accurate data collection, critical thinking and scientifically-informed decision making. This increases scientific capacity, better informs decisions and improves social capital in South Africa, particularly pertaining to plant conservation. This has allowed the network of citizen scientists to be active beyond just monitoring plant species of conservation concern as they contribute to other activities such as collecting seeds of threatened species for the Millennium Seed Bank Partnership, recording presence of invasive alien plants and assisting local municipal monitoring projects", (CREW, 2019:3).</i>	This description, is extracted from the draft 2019 CREW Operations Manual, summarises the forms of activity for which citizen scientists are being mobilised. It illustrates how the links between data collection and applied biodiversity management are being articulated for citizen science volunteers in the programme.
Leveraging scientific data to inform emergency municipal management strategies	<i>"The CREW team contributed to this workshop [related to Cape Town's water emergency in 2018] by providing threatened plant data, and subsequently identified two main sites of concern - Steenbras Dam and Wemmershoekvlei. As a result of this intervention, the City of Cape Town has established an environmental working group to advice [sic] on locations for the next drill sites as well as guaranteeing environmental compliance" ... "Having already drilled the boreholes at Wemmershoekvlei and started installing a pipeline, the municipality's Environmental Control Officer was alerted and supplied with a detailed map ... of the populations of threatened plants at the site" ... "The CREW CFR node arranged seed collecting" ... "[t]he area will be rehabilitated after the pipeline has been completed" ... "the CREW Friends of Tygerberg Hills (FOTH) group will be involved in monitoring the site", (Parbhoo, 2018:13).</i>	Here, CREW was able to draw on previously collected data to re-negotiate emergency drilling for water during the 2018 drought in South Africa. While the biodiversity knowledge was unable to stop emergency drilling, it was able to inform better drilling strategies, as well as inform after-drilling restoration strategies.

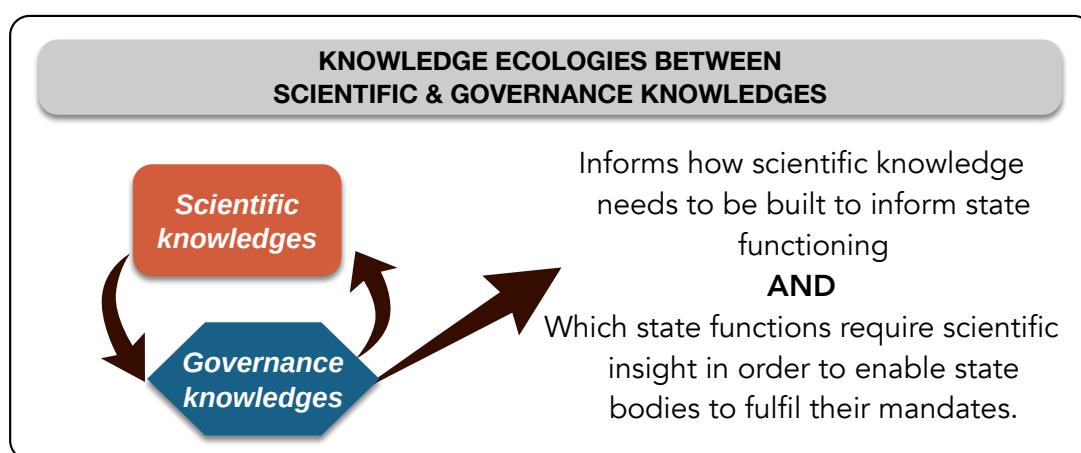


Figure 34: Using scientific knowledges and governance knowledges to focus and shape knowledge production activities.

The above extracts illustrate a range of diverse interactions between governance and scientific knowledges, in relation to policy development and articulation, policy intervention, and applied management and governance across different scales and systems of activity. Alignment between these two forms of knowledge and their privileging in official reporting systems is also evidenced through the structures and forms of annual reports as well as the 2019 programme review report (Stewart, 2019). In these reports, programme activities are framed in scientific terms, and represented in systems of graphs. Clear links are created between programme activities, scientific value and policy implementation (see, for example, Mohan, 2019; Parbhoo, 2018; Parbhoo, 2017).

7.2.3.2. Situated or Contextual Knowledges

Additionally, volunteer teams of citizen scientists leverage their knowledge of specific contexts to identify which areas are viable as data collection sites, and what the embodied social-ecological risks impacting on specific populations of plants are. This introduces a third form of knowledge – what we can call situated or contextual knowledges – into the ecology of knowledges being used in this programme. These situated knowledges contribute an understanding of the contexts within which rare plant communities are found, and, in combination with governance knowledges, which state actions would be appropriate for their protection. Situated knowledges inform government stances in terms of species conservation, land-use practices, and biodiversity management strategies, etc. They also inform future protocols and data collection plans, based on in-field experiences, concerns and risks. The below extracts illustrate the engagement of situated knowledges into the ecology of knowledges within the CREW programme:

Table 12: Illustrative evidence of situated, contextual knowledges

Situated/ contextual knowledge aspect	Illustrative evidence	Analytical notes
Situated knowledges to recommend applied conservation actions, and reflect on situated changes in specific sites	<i>"In early July we ventured up the Paardeberg for Erica hippurus (EN). The impenetrable vegetation around the locality is moribund and the fuel load is high, as pine trees have been felled. The site needs a burn, but thousands of pine seedlings will probably appear"</i> (SANBI, Broddle, 2019:22-23). <i>"A huge swathe of pine trees had been removed and a fire-break made - and what a delight that turned out to be! Gladiolus watsonius (NT), Aristea lugens (EN) and Geissoriza imbricata (NT) were some of the special species recorded"</i> (SANBI, Hellmann, 2019:25).	In these two extracts, Broddle describes the impact of a pine plantation on local plant communities. Broddle notes a range of compounded impacts in the site drawing on situated knowledge and observations. In the second contrasting extract, Broddle illustrates the impact of an alternative method of removal on the local plant populations. *NT - Near Threatened EN - Endangered

Situated/ contextual knowledge aspect	Illustrative evidence	Analytical notes
Protocols for how situated knowledges should be used to inform recommendations within the BSP programme	<i>"With very limited capacity in all of the provincial Biodiversity Stewardship Programmes (BSP), it is key to work closely with the BSP officials in your region so that you can support them in the process of proclaiming new areas and in the process keep proclaimed sites well managed. This entails:</i> <i>- Engaging with your local BSP officers and working with them to highlight key sites for threatened plant conservation;</i> <i>- Regularly visit stewardship sites in the process of being proclaimed or already proclaimed and provide feedback to landowners" (CREW, 2019:9).</i>	This extract from the draft operations manual illustrates one approach to managing how situated knowledges can be used to inform management advice. In this case, knowledge of local stewardship sites, and who the BSP officers are count as situated knowledge.
Situated knowledges informing and shaping governance planning	<i>"[E]ach site is assessed by desktop analysis of possible species occurring on the site, botanical surveys are carried out to ground-truth species occurring on the site, concerns highlighted by CREW citizen scientists who may have a close-eye on the site area raised, and recommendations on the management plan for the particular site is made" (Mohan, 2019:14).</i>	This extract illustrates the leveraging of situated knowledges in informing management actions within specific locations. Situated knowledges are engaged in relationship to scientific knowledges (botanical surveys) and governance knowledges.
Situated knowledges informing viable survey sites	<i>"A long history of dairy farming in the region means that steep slopes and roadside verges are the only areas left of any interest" (SANBI, Young, 2017:41).</i>	Here, Young illustrates of saturated knowledges are used to both describe and make sense of species distribution and to inform and maximise success in site sampling strategies.
Impact of contextual conditions on particular plant species	<i>"[T]he endangered Zeuxine africana eluded us for yet another year at Bayhead Mangroves. This invasive alien plant-infested site needs an eradication strategy, planned grassland burn, modest maintenance of the boardwalk and refuse removal" (SANBI, Raulstone & Browne, 2019:36).</i> <i>[W]e found that Tephrosia inandenis had been very successfully re-established at the Roosfontein Nature Reserve by the eThekweni staff. The plants were flourishing in full sun as the area was now cleared from encroaching trees" (SANBI, Raulstone & Browne, 2019:36).</i>	These extracts illustrate two variations of situated knowledge with regards to alien invasive plants and their impacts on local plant populations. Both extracts provide insightful commentary on why plant species are being affected in particular ways. In the case of the first extract, situated knowledge is used to recommend particular management strategies; in the second, to reflect on the success of particular management strategies.
Situated knowledges used to inform sampling and monitoring schedules	<i>"Our first trip in October to Lotheni to find Cyrtanthus falcatus (Rare), produced hundreds of plants, but no flowers. We were about three weeks too late. We now know where they are and there is always next year", (SANBI, Matcher, 2019:38).</i> <i>"It has been a tough year with tremendous fires, low rainfall and four unexpected late frosts, which not even the aloes could withstand ..." (SANBI, Maxted, 2019:40).</i>	These extracts illustrate the use of situated knowledges to make sense of poor sampling conditions and to inform future strategies for sampling and monitoring in the same areas.
Situated knowledges to make sense of local population distributions	<i>"The Mudén population has been destroyed because the land has been ploughed up for cultivation. However we found a new population on a seep cutting that was protected from grazers" (CREW, Young, 2019:38).</i>	Young describes why a local population of plants are distributed in a particular way, and what the ongoing effect of current land-use practices will be on this population.
Situated knowledges used to articulate local risk to plant populations	<i>"Unfortunately it is a continuous battle to keep roaming cattle out of the seemingly vacant land" (SANBI, Middleton, 2017:41).</i>	Middleton describes a situated risk to a particular site.

Situated/ contextual knowledge aspect	Illustrative evidence	Analytical notes
Situated relationships engaged towards meeting CREW outcomes	<i>"We work with threatened plant conservation but we engage lots of community groups on the ground that help us - they feed information to us, but they also, in their own way do conservation-related work as the organisation that they are or the group of people that they are. So for example the Friends of Tygerberg get involved in all sorts of stuff ... CREW is one of their main things, but they also do alien clearing and they do support for the Tygerberg Nature Reserve"</i> (Ebrahim, 2014).	Here Ebrahim describes the relational ways in which citizen scientists are connected into various systems of activity in particular contexts. Here and in other extracts in this table, it becomes evident how these relational connections are leveraged to inform CREW activities.
Governance knowledges and situated knowledges combined to inform site survey strategies	<i>"Site choices have been largely helped by a productive meeting with Bongani Zugu (Working for Fire at eThekweni Municipality), during which he furnished us with a detailed map of the municipal-owned grassland sites and details about which of those had been burnt recently. Concentrating on these sites, we have built up a sizeable flowering plant list for each site"</i> (SANBI, Sutherland, 2017:39).	Sutherland describes a reciprocal relationship between a municipal official and the CREW team; here situated knowledge of applied management strategies are shared to inform the site survey schedules for the node.
Situated knowledges to enrich landowner feedback systems	<i>"Apart from their regular monitoring, the group has been requested to survey sites and compile species lists for landowners (particularly for those interested in eco-tourism), architects, and developers and, more recently, non-government organisations working towards Biodiversity Stewardship"</i> (Parbhoo, 2018:8).	Parbhoo describes a range of land-use activities which CREW volunteers inform. The diversity of land-use options require volunteers to extend beyond survey results into making meaning of those results in relation to particular situated applications.
Situated knowledges for retrospective reflection and future prediction and preparation	<i>"It rained! The outlook at the start of 2018 was bleak, but welcome winter rains brought relief and standing water to the drought stricken area. Looking in wetter environments became feasible again."</i> <i>... "we visited for the first time, a section of Blaawberg Farm that had burnt in January 2018. On the servitude under the ESKOM pylons we found numerous red-listed species" ...</i> <i>"Later that month we visited Nirvana Fynbos Reserve near Atlantis, a fantastic piece of Atlantis Sand Fynbos, recovering well after prescribed burns in 2011 and 2012"</i> (SANBI, Broddle, 2019:19). <i>"The Sandown Fynbos Corridor continues to yield surprises. This area has seen some alarming transformations due to the increase in housing developments, but this corridor is critical for survival of the plants and animals in the area"</i> (SANBI, Broddle, 2019:20). <i>"In preparation of the restoration and burning of the Swartland Shale Renosterveld on Blaauberg Hill in 2019, we have been recording the existing plant populations on a regular basis"</i> (SANBI, Broddle, 2019:20).	In these extracts, Broddle illustrates an ongoing leveraging of situated knowledges to inform and make sense of site conditions, as well as plan for future node activities. The situated knowledge is both reflective of past activities and predictive of future contextual impacts within local sites.
Situated knowledges to respond to localised land-use patterns and community movements	<i>"We have been monitoring and recording plants here over a few years and have had our ups and downs with keeping the movers and vehicles at bay. Concerned parents from the nearby school became involved, first by fencing off the park with droppers and tape before a sport event to prevent vehicles from parking there, and then requesting quotes for putting up a post and rail fence"</i> (SANBI, Lochner, 2019:32).	Here Lochner describes a risk-responsive approach drawing on situated knowledges of community patterns and movements.

Situated/ contextual knowledge aspect	Illustrative evidence	Analytical notes
Situated geographical and management knowledges in relation to biodiversity surveying	<i>"A key purpose for this Table Mountain field trip was to search again for Microdon nitidus, one of the Peninsula's 'lost plants', not recorded since the 1950s when Elsie Esterhuyse collected it near the top of Skeleton Gorge. A thorough search of the target area proved fruitless ... My suspicion is that this is another plant that will make a reappearance after fire, so we should thoroughly explore the top of the Nursery Ravine in spring 2019"</i> (SANBI, Laidler, 2019:17).	Here Laidler describes two forms of situated knowledge - first that of specific geographical locations with local names, and secondly how a local management event at a particular time (before spring 2019) might impact on a plant population.
Historical reflection on impact of development on specific plant species	<i>"One of the species found is the Endangered Hesperntha sufflava (CR), which we thought was extinct after the last known population was bulldozed for a housing development. Discussions are underway to raise the profile of the site and to initiate Biodiversity Stewardship options"</i> (Parbhoo, 2018:7).	Here Parbhoo provides a historical account of context and the impact of historical activity on a plant species.
Establishment of networks between volunteers and local conservation agencies and land stewardship programmes	Grieve, reporting node activities, noted that, <i>"[t]wo members of the group represent CREW on the advisory committee for the newly declared Weza-Ngele Forest stewardship site, covering the area between Weza and the boundary of the DAFF reserve"</i> (SANBI, Grieve, 2017:37).	This extract illustrates CREW participation within a local advisory committee. Contributions to such committees require a combination of scientific knowledges (site species), governance strategies (stewardship regulations and bylaws) and situated knowledges (understanding of the contexts of land-use, settlement and interested and affected parties, for example). Also see SANBI, 2017.
Informing urban planning and management	<i>"We inspected this verge for about 100 meters and found in the region of 100 plants in various stages of flowering" ... "We returned to the site a month later to see whether any plants were still in flower and if seeds were present. To our absolute horror the verge had been brush cut and we found very few plants remaining - let alone in seed. I then contacted Richard Boone regarding the municipality's roadside management. This prompted his colleague, Lance Rasmussen, to put in place a management programme for verge cutting, which takes into account preservation of species of conservation concern"</i> (SANBI, Sutherland, 2017:39).	In this illustration, the CREW team made sense of a drastic change in plant population, drawing on situated knowledges of the area. This situated impact was then reflected back into the management system in order to manage future risk.
Situated risk within a local context	<i>"Twenty threatened species were recorded and we anticipate more. The site [Preekstoel site] was strip-ploughed in the past, and is now threatened by acacia invasions, and sand mining is also taking place on surrounding farms"</i> (SANBI, Broddle, 2019:22).	Broddle describes a range of situated risks to the threatened species in a local context.
Situated knowledges of changing land-use to inform plant rescue strategies	<i>"We have participated in eight Search & Rescue efforts on land earmarked for development. All the sites, some with red-listed species, have since been developed. The Search & Rescue methodology is flawed and requires review"</i> (SANBI, Broddle, 2019:20).	Broddle describes both a particular local condition - that of housing development - on local plant populations, as well as the impact of flawed collection protocols which have not held up well within this particular context.
Situated knowledge and risk identification	<i>"Ezemvelo KZN Wildlife's recent acquisition of Fairview near Umzombe necessitated an assessment of plant diversity and rehabilitation potential of the site. Threats are posed by cattle grazing, mouth harvesting and sand mining"</i> (SANBI, Grieve & Grieve, 2019:34).	In this extract, Grieve and Grieve describe a contextual change in governance structure, and refer to the need for a particular form of scientific knowledge (species lists), as well as identified situated risks which will need to be taken account of in future management of the site.

Situated/ contextual knowledge aspect	Illustrative evidence	Analytical notes
Situated knowledges as a resource to inform future planning and species protection strategies	<i>"A new road is planned to go through Driehoekpad within the next three years, so we will need to make sure that the population of Watsonia dubia affected is moved"</i> (SANBI, Hellmann, 2019:25).	Here Hellmann leverages situated knowledges in order to strategise on future actions needed to protect a particular species in a specific context.
Situated knowledges to inform sampling and site surveying	<i>"Most of the Pondoland CREW outings took place within the Umtamvuna Nature Reserve, destinations determined by flowering or fruiting times, or the need to monitor or collect certain species (as well as weather conditions!)"</i> (SANBI, Grieve & Grieve, 2019:34).	Grieve and Grieve describe the use of situated knowledges about weather and seasonal conditions to inform survey planning.
Situated knowledges in recurrent site surveying	<i>"The entire western face and top ridge had burnt in November 2017, which had cleared the very dense growth ... we were able to confirm most of the 180 species found at the end of the day ... We have informed the new land owner of all the rarities that occur on this farm and hopefully he will protect them from grazing"</i> (SANBI, Preston, 2019:24). <i>"We were also asked to walk an area on the farm Alexanderfontein just outside Darling, where a south-facing slope had been brush-cut in July. Unfortunately, they cut too close to the ground damaging the rootstocks of the larger shrubs and even the wild olives"</i> (SANBI, Preston, 2019:24). <i>"The damaged area in the Renosterveld Reserve, which was scraped to make a parking area for Day Zero, showed good signs of recovery after the rains and weeding by the municipal workers. It was amazing to see what had survived and was emerging after the disturbance"</i> (SANBI, Preston, 2019:24-25).	In these extracts, Preston illustrates the ways in which situated knowledges are used to evaluate and make sense of changes in site conditions over time. The knowledge being used is situated in that it is site specific and related to land-use practices over time.
Situated knowledges and articulated risk and uncertainty	<i>"[We] joined Ismail on an outing to the Steenbras dam area where borehole drilling into the deep aquifers had already started. We sampled an area to the south of the dam not far from a borehole. Here we found the tiny Erica multiflexuosa (VU), which is, according to the Red List, extremely localised around the Steenbras dam and had already lost 50% of its habitat to the construction of the dam. Who knows how drilling operations will affect it in future"</i> (SANBI, Lochner, 2019:31).	Lochner engages situated knowledge to both reflect on an identified contextual risk, as well as to express uncertainty related to a situated event. There is reference to both scientific knowledges (relating to distribution patterns), as well as governance knowledges (linked to the urgency of the drill site for municipal water supply under emergency conditions). *VU - Vulnerable

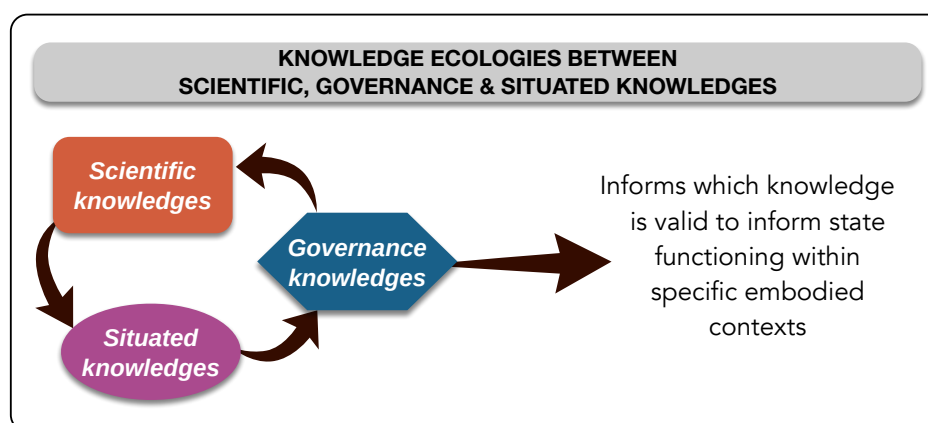


Figure 35: Using situated knowledges to inform knowledge building and state functioning within specific local contexts.

29 of the 33 illustrative examples of the mobilisation of situated knowledges were sourced in more informal publications (CREW newsletters). Mention is made of local and indigenous knowledges within the recent review (Stewart, 2019:35), which recommends retaining and expanding partnerships with “local actors with local knowledge”; and within Targets 9 and 13 of the National Strategy for Plant Conservation, which describe the need to conserve species while respecting, preserving and maintaining associated indigenous and local knowledge. However, Target 9 is not one reported on, and CREW’s engagement with Target 13 focuses on indigenous knowledge (see next section). Even within the newsletters, many of the nodes did not reference their own mobilisation of situated knowledges, nor describe them as either local, situated or contextual knowledges; instead the clear focus was on reporting scientific and governance outcomes, with situated knowledges described implicitly. However, the examples clearly illustrate the integrated and significant contribution of situated knowledges to the development of scientific knowledges as well as implementation of applied management and governance systems.

The difference in representation and lack of explicit naming suggests that situated knowledges are seen as less powerful, and are not currently legitimated within the programme as an official form of knowledge. It would be interesting to investigate which groups of people within the project (scientists, citizen scientists, government agents and representatives) are using situated knowledges, how situated knowledges are viewed by different groupings, and whether this form of knowledge is considered legitimate. In terms of epistemic justice, we could ask whose knowledge is currently unrecognised or recognised as secondary and less powerful, and what does the absence of situated knowledges within reporting structures imply about power dynamics in relation to both cognitive and distributive justices within the project?

Within the CREW project, situated knowledges seem to profoundly enhance and strengthen the ability of citizen scientists to make meaning within local contexts, as well as to more effectively build scientific knowledge, apply governance knowledge and inform future knowledge production activities.

7.2.3.3. Indigenous and spiritual knowledges

In some areas with CREW, we also see the inclusion of indigenous knowledges and spiritual knowledges into the ecology of knowledges. Citizens and programme staff engage with

communities who harvest rare species for indigenous and/or spiritual practices for example. An understanding of how plants are used and harvested, and for which purposes, become significant in two key ways: a) in terms of impact on plant populations, and b) in terms of the rights of communities using these plants in their traditional practices. The ecology of knowledges in the programme then interacts in ways that take account of the role of the state in what are potentially oppositional state functions within a particular context – the right to a healthy environment for all citizens of the state, and the rights of communities to live in ways that enable them to practice their cultural heritage and freedoms. The below extracts indicate some ways in which CREW staff and volunteers are starting to engage with - or at least recognise - the significance of indigenous knowledges in relation to plant conservation:

Table 13: Illustrative evidence of reference to, and engagement with indigenous and spiritual knowledges

Indigenous and/or Spiritual Knowledge Aspect	Illustrative evidence	Analytical notes
<i>Connecting to parallel systems of governance related to building and maintaining indigenous knowledge systems</i>	<i>"The Department of Science and Technology's National Recordal System project works to document the indigenous knowledge held by South Africans. The project operates under the Indigenous Knowledge System Policy 2004. It is the largest South African initiative to record, document preserve and protect indigenous knowledge for the benefit of the communities of the country ...Strengthening of the relationship between the National Recordal System project and CREW presents an imminent opportunity to expand CREW's demographic reach, whilst assisting the DST within the bounds of CREW's existing human and financial resources" (Stewart, 2019:30).</i>	Stewart, in this extract, is recommending one way to expand the demographic reach of CREW volunteers. The point is related to harnessing indigenous expertise while contributing to building record systems of indigenous knowledge.
<i>Traditional practices as risks</i>	<i>"Over-exploitation for the informal muthi [medicinal plant] trade has resulted in this species becoming Vulnerable" (SANBI, Egan, 2017:52).</i> <i>"The species is at risk from ongoing harvesting for medicinal plant trade", (SANBI, Pretorius, 2019b:41).</i> <i>"It is becoming imperative to document the biodiversity of this nature reserve because each year sees more and more tourists illegally driving un-guided into the delicate grassland system and the mountains are also becoming the target for uncontrolled medicinal plant collectors" (SANBI, Egan, 2019b:45).</i>	Here Egan and Pretorius describe the impact of traditional plant trade on a particular species of plant. The framing of harvesting patterns as over-exploitation, given large-scale biopiracy of medicinal plants by corporate pharmaceutical and cosmetics companies opens up questions of how legitimate harvesting are determined, and whether distributive justice is considered within such definitions.
<i>Intergenerational and inter-knowledge exchanges</i>	<i>"[W]e walked and worked a great deal with our Fourcade Botanical Group Juniors. We wanted to learn from them what they knew about our local plants and how they used some of them" (SANBI, Logie, 2019:26).</i>	Logie describes a more informal process of exchanging different forms of knowledge with youth groups, where the CREW node supports development of scientific skills, and learn about traditional and local practices from youth.

Indigenous and/or Spiritual Knowledge Aspect	Illustrative evidence	Analytical notes
<i>Governance systems and indigenous knowledges, related to plant species knowledge building and management</i>	<i>The National Strategy for Plant Conservation identifies the following in relation to indigenous knowledge: Target 13: Indigenous and local knowledge innovations and practices associated with plant resources maintained or increased as appropriate to support customary use, sustainable livelihoods, local food security and healthcare. The particular outcome identified as relevant to CREW is 13.1: The National Recordal System capturing and safeguarding Indigenous Knowledge, with the specific contribution described as: Future potential area for CREW support, knowledge recorders working on this programme need support to identify plants that are utilised by communities and training on to collect specimens (Stewart, 2019; Parbhoo, 2018).</i>	This extract indicates opportunities for expanding CREW activities to meet the mandate outlined in Target 13 of the National Strategy for Plant Conservation.
<i>Building records of indigenous plant knowledges</i>	<i>"This programme [Indigenous Knowledge Systems Project] involves working within particular communities to record which plant species is used, for what purpose and how it is used, thereby ensuring indigenous knowledge is safeguarded for generations to come" (SANBI, Mogale, 2019b:10).</i>	Here Mogale describes the need to create records documenting indigenous knowledge related to plants. In reference to the same programme, CREW also identifies the need for work informing policy and management of harvesting of medicinal plants, as well as supporting law enforcement activities (especially in reference to Maputoland regions). See, for example, SANBI, 2017 and Parbhoo, 2018.
<i>Integrating new forms of expertise into CREW volunteer groups</i>	<i>"Partnering with existing medicinal plant collectors who already know a vast number of species in the landscape, understand their traditional and commercial applications, are familiar with their local area, and are comfortable working in nature may present a further suitable strategy [for expanding the demographic range of the programme]" (Stewart, 2019:30).</i>	Here, Stewart recommends a specific strategy for expanding demographic range of CREW volunteers, based on indigenous knowledge of plants (rather than scientific knowledge, as with many existing volunteers).
<i>Illegal plant trade as a risk to indigenous practices</i>	<i>Informing Muthi (medicinal plant) market surveys. Mogale notes that this project "came about as a result of traditional healers voicing their concerns over the high rate of illegal traders that are exploiting the natural resources. This raises significant concern as the province's already scarce plants populations are being depleted, which affects traditional healers who require the resource to heal their community members" (SANBI, Mogale, 2017:19).</i>	Mogale, in contrast to Egan above, recognises the significance of traditional plants within indigenous healing practices, and describes risk in relation to a lack of available plants for this particular use.

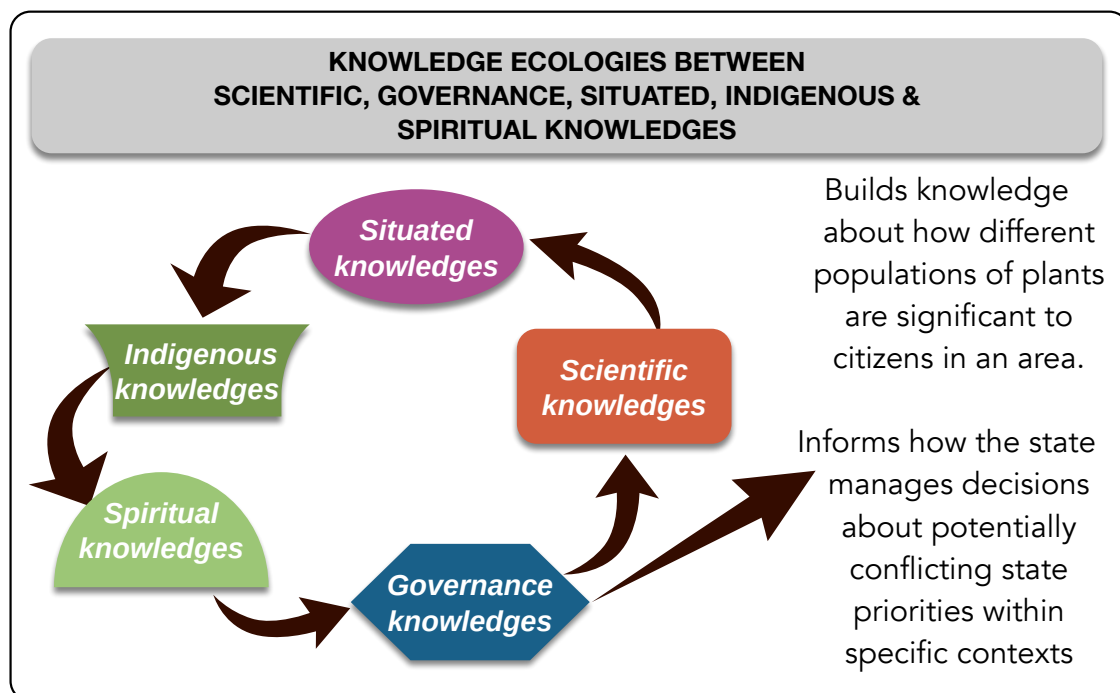


Figure 36: Using an 'ecology of knowledges' to inform localised risk and state responses within context.

This final table illustrates the integration of new form of knowledges - indigenous and spiritual knowledges - into the ecology of knowledges within the CREW programme. As can be seen, this form of knowledge is neither well established (within the programme context), nor clearly understood and legitimated; instead engagement is related to identifiable risk, and to establishing knowledge systems and processes for reconciling indigenous plant knowledge with both scientific knowledges and governance knowledges. Based on these extracts, not all members of CREW share the same perspective on indigenous knowledges in relation to building scientific knowledges and governance of plant species. In relation to epistemic justice, there is no mention of regulations and intellectual property mechanisms to safe-guard indigenous knowledge systems within the documents reviewed (although this does not mean that such mechanisms are not outlined in specific documents not reviewed here).

7.2.4. General Comments

The CREW case study illustrates a rich and complex ecology of knowledges which are effectively being engaged in response to a range of social-ecological risks, as well as epistemic outcomes. In the light of this analysis, the description of the CREW programme as "data-driven citizen science" (SANBI, Parbhoo, 2019:3) is perhaps not completely accurate. As evidenced above, the strong integrity of data within the project is only one key component of the substantial work

being done within a vast system of commoning as knowledge production and mobilisation in response to social-ecological risks. It is evident in this case that different knowledges work together at diverse times to inform a variety of responses to social-ecological risk across multiple scales. Each of the knowledges within this ecology of knowledges, together and individually, therefore makes new knowledges and possibilities visible within a context of embodied risk.

Also clear is that the production of scientific knowledges in this case, would not be possible without the other knowledges being mobilised.

7.2.5. Mobilisation of Knowledges in Response to Social-Ecological Risk

Knowledges being generated within this ecology of knowledges is being mobilised in a range of ways, and especially evidenced in three areas:

- Scientific knowledges are being produced - both in the form of peer-reviewed literature, as well as through applied conservation knowledge such as species lists;
- Governance knowledges are being produced in the form of policy initiatives (or at least substantive contributions to such initiatives), as well as the establishment and implementation of a range of applied governance mechanisms across scales from local through to international scales;
- Local actions and responses to contextual risk are being informed by citizen science activity, often leading to local conservation and preservation efforts, as evidenced by the extracts related to situated knowledges especially.

The project demonstrates a flexible and contextually responsive mobilisation of knowledges in response to a *system* of inter-related risks, rather than one clear biophysical risk, as commonly described in project reports and other official documentation. Nor are all risk-responsive strategies mediated by state or scientific institutions.

7.2.6. Reneging State Mandates versus Participatory or Radical Democracy

One of the areas of concern is the precarious relationship between State mandate and civic participation in the governance of natural resources, and the articulation of civic contributions to such endeavours. The recent evaluation report (Stewart, 2019) clearly foregrounds a State mandate within a project which is supposed to be a collaborative partnership with various civic organisations.

The CREW model has proven to be an effective vehicle for botanically-focused citizen science in South Africa. However, risks to its current effectiveness and future effective scaling-up include the potential to be drawn into tasks that fall outside of SANBI's core mandate and the programme's core purpose. Most notably, a risk exists of capacity building and demographic expansion efforts diminishing available human resources to address core SANBI mandates (Stewart, 2019:iv).

The evaluation report simultaneously notes a decreasing State investment towards fulfilling that mandate:

Financial support from BotSoc and Mapula Trust has been vital to the effective implementation of the programme, both in terms of staffing and operational cost and has ranged from covering 18% to 47% of the costs of the programme in different years", (Stewart, 2019:23) (excluding contributions in kind and supplemented by volunteers) ... : "SANBI's budgetary provision for stand costs increased consistently from 2006/2007 to 2009/2010, but then reduced substantially in 2010/11 and remained constant into 2011/2012 ... SANBI's budgetary provision for salaries from 2012/2013 onwards either increased slightly each year or remained constant. From 2006/7 until 2012/13, SANBI's budgetary provision for operations remained fairly constant. A substantial increase in operational budget was experienced in 2013/14, but this decreased by almost 50% the following year. A further almost 50% decrease was experienced in 2016/17" ... "The need for ongoing and additional external funding is essential, due to regular reductions in government budgets (Stewart, 2019: 23-24).

Both the evaluation report (Stewart, 2019) and the 2017 annual report (Parbhoo, 2017) highlight the invaluable contributions of both citizen scientists and civic organisations. Highlighting the contribution of citizen scientists through this project, Raimondo points out that,

[a]t a time when government funds for conservation are highly limited and funds to conservation agencies to monitor biodiversity are being radically cut, the unrelenting commitment of CREW citizen scientists to monitoring the status of our plant diversity provides an immeasurable contribution to the conservation of South African's unique plant diversity (SANBI, Raimondo, 2017:2).

Stewart adds that,

Leveraging the goodwill, expertise, time and financial resources of volunteer citizen scientists has enabled SANBI to acquire vastly more data via CREW than it would have had the programme been implemented using only SANBI staff (Stewart, 2019:22).

Read together, these quotes point to an alarming conflation between the roles of the State and those of civic partners, skewed towards State benefit. Narrations of the roles of various partners (at least within the documentation reviewed) show that the State (and its actors) dominate articulations of knowledge, risk, and value, and that such narrations forward a neoliberal hegemony.

A stronger example of participatory democracy is evidenced in the following quote:

Key sites for threatened and rare plants are being lost within local municipalities due to a lack of awareness, ignorance or deliberate efforts to avoid addressing legal requirements by local municipal officials, councillors, engineers, contractors and private landowners, amongst others. CREW could implement targeted interventions to raise awareness of key sites for threatened and rare plants at a local municipal level ... (Stewart, 2019: 23)

... but this is undermined by the qualification which follows, and demonstrates the potential appropriation of civic democratic engagement with state function towards fulfilling state mandate, instead of enacting participatory democracy.

This would support the work being undertaken by SANBI's Policy and Advice Branch. Such an initiative needs to be targeted and have longevity built into it, to address the challenge of working across such a vast number of municipalities and the high turnover of officials and councillors within them (Stewart, 2019:23).

Many of the risks and challenges described within the evaluation report (Stewart, 2019) for example, are related to governance issues, and the fulfilment of State mandate. They are risks articulated from a perspective of maximising free human resources in the form of volunteers contributing data, and reducing the (mandated) responsibilities of the State. This perspective would shift if the programme was also considered from a perspective of participatory democracy, which might, for example, provide an argument for stipend-based monitoring, rather than delimiting programme activities on the basis of where free human resources are available. Currently, value is quantified in terms of productive output per employed staff member, with financial value per targeted outcome being the basis of calculation (Stewart, 2019:19). Seeing the people of South Africa as co-contributors and also equal rights holders to the biodiversity system of South Africa opens up the forms of engagement and activity which might be privileged within such governance oriented citizen science.

The risk of the current framing of citizen science contributions is that it might set into place a process of the State 'outsourcing' the roles it is mandated to fulfil to the citizenry. This could, for example, result in decreasing allocations of State funding as citizens begin to take on the costs of such work, as is already evidenced by the reduction of State funding within CREW. It might also result in fewer government staff, and a shift in skills priorities of such staff as citizens fulfil stronger monitoring tasks. Moreover, this form of articulation could potentially usurp and undermine the participatory democracy role of civic organisations through recruitment into fulfilling State mandates, reducing their efficacy to hold the State accountable to its mandate.

Neither BotSoc nor SANBI have a clear articulation of how participatory (and perhaps, radical democracy) can and should be enacted as part of the individual organisational mandates, and certainly not within the CREW partnership (see, for example, summaries of both institutional mandates in Stewart, 2019). It might be of benefit for each of the organisations involved to

develop a 'terms of reference' in relation to their democratic contributions to this form of project in the future. Another suggestion is the co-authoring of project reports - if reports were co-authored by BotSoc or other node partners (as the civil society partners), and SANBI, there would be potential for a 'fertile tension' articulating the priorities of both parties in addition to developing one form of epistemic justice in terms of representation and narration. An initial (although poorly articulated) example of the fertility of such an approach can be seen in the annual newsletters - many of the data entries in the evidence tables above show the richness of such collaborative writing processes.

7.2.7. Produced Nonexistence versus Epistemic and Distributive Justices

As evidenced in many of the CREW group articles (SANBI, 2017), the strongest focus on reporting is around species sightings and data listing. Many reports exclude any articulation of other knowledges or activities related to education, applied conservation, or other project activities. Citizen science is described as primarily a scientific endeavour (see, for example, Araya, Schmiedel & von Witt, 2009), but this case study illustrates the robust mobilisation of citizen scientist contributions towards governance and applied conservation across a range of systems and scales of activity. Clearly, the CREW project has begun to generate a commons relating to rare plant conservation which goes beyond scientific data sheets, and involves a wide range of commoning activities. As Warren reminds us, "these outings are done by people and not just forms" (SANBI, Warren, 2017:43), and Maxted adds, "[t]he one thing we all have in common is that we love flowers. This of course does not mean that we know what any are called" (SANBI, Maxted, 2017:45).

In my interactions with this project, it was clear that the employed SANBI staff exhibited a great deal of respect and camaraderie with citizen science volunteers, and valued their various contributions greatly. However, this mutually respectful relationship is less evident in official reporting channels beyond acknowledging primarily scientific data-based contributions to the project. There is little evidence of epistemic justice or distributive justice within the official reporting and management systems in the project. The framing of volunteer contributions as 'return on investment', rather than as an effective and functional system of participatory democracy requires challenging. There is work to be done to reframe how citizen science

contributions are narrated, and to integrate more robust and just forms of narration into programme articulation and reporting.

7.2.8. CREW Case Conclusion

This project demonstrates a rich and complex ecology of knowledges, which is being produced and mobilised across scales and a range of epistemic and governance purposes. It provides a highly successful example of one model of citizen science which can be leveraged as a form of participatory governance. However, there are issues of cognitive and distributive justice which require redressing in order to strengthen the justices and foreground an interest in the common good.

This is not to say that initiatives such as CREW are not powerful in their current form - clearly they are; instead, it calls for a more accurate and expansively rigorous articulation of the system, and a clear distinction and articulation of the contributions of citizen scientists as enacting various forms of participatory and/or radical democracy, rather than being framed as extensions of State function. Instead of being framed as a free (skilled) labour resource which the State can exploit towards its own interests, citizen scientists could be framed more accurately as civic collaborators in *shared* initiatives related to biodiversity management (in this case). Here the State would still be required to hold responsibility and mobilise resources for fulfilling its own tasks and mandates, and citizen scientists would partner through civic action that enacts robust and (where possible), collaborative forms of participatory governance.

The argument above is not aimed at challenging the clearly powerful alignment between SANBI and the CREW volunteers (and the civic organisations they represent), but rather to highlight the precarious articulation of this alignment. There is a democratic danger in appropriating civic participation in biodiversity management for the fulfilment of state mandate. Through the arguments above, I want to suggest that State and civic roles should be distinguished, that State mandates should be funded by State systems, and that civic roles should be framed in a manner which align with principles of participatory (and even radical) democracy. Such collaborations have the potential to enhance the dual system democratic practice enshrined in, and called for, in the legislative framework of the country.

7.3. Illustrative Case Study 2: Khulumani Water for Dignity

The *Khulumani Water for Dignity* project¹²⁰ focused on issues around water quality and provision in the city of Grahamstown¹²¹, which falls within Makana Municipality in the Eastern Cape province of South Africa. Citizen scientists¹²² and university scientists collected data about water issues being experienced in one part of the town. The project is formed through a partnership between a group of citizen researchers, Rhodes University researchers (through the Towards Practicing a New Paradigm' (TPNP) project) and the Khulumani Support Group (KSG) - a civil rights group.

Context of concern: Residents of Grahamstown were concerned about quality and quantity of water supply within Grahamstown East. Grahamstown East is the township portion of the City of Grahamstown; the term township refers to settlement areas on the outskirts of towns¹²³ in which Black, Coloured¹²⁴ and Indian residents were forced to live (race-designated and separated) during the Apartheid era in South Africa. Townships received, and still continue to receive in many ways, minimal service provision, infrastructure and municipal attention, although there are a number of national government schemes intended to address such imbalances. Grahamstown East is also where the majority of Grahamstown's population lives, with high unemployment rates, and comparatively low levels of financial and social capital, (Weaver *et al.*, 2017). In a response to an article aimed at identifying what precisely the water problems were about in the local Grocott's Mail Newspaper (25 October 2013), the 'Towards Practicing a New Paradigm' (TPNP) project team, who are partners in this project, noted that,

[t]he first thing to realise is that there isn't one "root", there is a tangled network of roots, and they go very deep, and in lots of wiggly directions ... (Palmer & Munnik, 2018:58).

120 A preliminary case description of this case study was also presented in Lotz-Sisitka *et al.* (2018:50-57), in addition to the early version of this chapter published as Vallabh (2017).

121 Grahamstown was officially renamed as Makhanda in 2019. I have maintained the use of the name Grahamstown in this thesis in order to maintain clear links to references in data sources.

122 Citizen scientists were referred to as 'civil society research partners' within the wider programme. I have opted to substitute the term 'citizen scientist' in this case, after negotiation with the civil society research partners concerned, for ease of reference within the context of this study.

123 This 'outsider' status is evidenced through their total exclusion in many Apartheid era geographical maps (see for example, Kelso, 1999). Townships have since been officially integrated into the urban centres which they were designed to service, but remain racially, socially and economically segregated in many ways. Townships are similar to what are referred to as 'slums' in other parts of the developing world.

124 The South African description of people of mixed race backgrounds, most especially between black and other race groups.

7.3.1. Project Partners

The Institute for Water Research (IWR), Rhodes University:

The Institute for Water Research at Rhodes University is a research institute whose focus is the generation of knowledge and water management practices contributing to the wise use of natural water resources in South Africa. The centre has a range of foci, including water-related research; targeted research into specific water-related issues and risks; research teaching and knowledge dissemination; policy and governance input on water management committees; capacity building and community education; and the development of practice-based resources to support wise and integrated water management practices. As part of their broader work, the IWR participated in a larger project funded by the Water Research Commission¹²⁵, entitled “Towards Practicing a New Paradigm (TPNP)”¹²⁶; the project aimed to develop diverse forms of praxis intended to improve integrated water management processes in South Africa (Weaver et al., 2017). The Makana Municipality was one of the case studies within this wider project, with a focus on the *Water for Dignity* project. The majority of data sources referenced here are project reports and publications for the TPNP project. The IWR had funding available to explore and support citizen-based research into water quality and related health impacts (Weaver, 2019). An engaged research process was envisioned as a space to explore the possible roles and contributions of civil society organisations in terms of promoting democratic local water governance, as well as local water issues (Weaver, 2019).

Khulumani Support Group (KSG): This is a membership-based NGO of more than 100,000 survivors of the gross human rights violations perpetrated during the Apartheid regime in South Africa, established in 1995. The organisation is concerned with “truth, healing, and redress for those damaged through our apartheid history, and for the advance of the ongoing struggle to create a democratic, non-racial and just society”, (KSG, 2019¹²⁶). KSG’s primary interest in the project in Grahamstown was linked to human rights violations in relation to inadequate clean water supply (Weaver, 2019).

Civic Researchers and Activists: A small group of civic researchers, already active in Grahamstown East, and familiar to the Rhodes University and Khulumani teams, were invited to

¹²⁵ The Water Research Commission is a national parastatal mandated to generate new knowledge and promote water-related research in South Africa.

¹²⁶ <https://khulumani.net/about-us/>; accessed 25 September 2019

participate in the project. The civic researchers had a history of working with communities in the area, and of advocating for basic human rights for their communities, one of whom had participated in KSG activities in the past.

7.3.2. An Emerging Partnership

The overlapping interest in democratic water supply and quality in Grahamstown East between the IWR and KSG provided a strategic base for their partnership (Weaver, 2019). For the IWR, this meant creating a component for civic research within their existing programme, and for the KSG, this involved situating what was later referred to as 'Water for Dignity' into their Victim Empowerment for Active Citizenship Programme (Weaver, 2019; Palmer & Munnik, 2018). Thus, Water for Dignity was 'engineered into formation' through this engagement between the IWR and KSG.

KSG's national director, Marjory Jobson, had a history of engagement with active citizens in Grahamstown East, and mobilised a core group through these relationships (Weaver, 2019). Through this engagement, Mbulelo Lipile (already engaged with KSG¹²⁷, and a resident of Grahamstown East) was invited to participate in the programme, and assisted in the mobilisation of a core project team. Marjory also facilitated drawing up the Water for Dignity project concept document, which served as a starting point with which to engage the community group (Weaver, 2019). The WfD team worked with the KSG to identify key water-related challenges, and begin to propose remedial actions, drafted into a formalised work plan (Weaver, 2019).

7.3.3. Broader Project Context

Although the citizen science component of the two feeder programmes was stimulated by these larger partners (IWR and KSG), a central focus of support activities were geared towards assisting citizen scientists to take ownership of, and drive, the citizen science project as equal partners in those areas of overlap between the three programmes. As is illustrated in careful detail in the case descriptions elsewhere (Weaver, 2019; Hamer *et al.*, 2018; Palmer & Munnik, 2018), there were a number of challenges and successes in achieving this intention, not least of which was the role of unstable incomes to support citizen science work; I will not be repeating

¹²⁷ At the time of writing this chapter, Mr Lipile had been elected to serve as the Chairperson of the National Steering Committee for KSG.

that analysis here as it falls outside of the illustrative purpose of this case study and has been covered in depth by those more directly involved in the project.

The citizen science project was modelled on a previous project in the neighbouring Sunday's River Valley Local Municipality, but varied significantly in terms of civic engagement, co-ownership, and collaborative design (Weaver, 2019; Hamer *et al.*, 2018). The concept of 'Water for Dignity' was born out of a meeting between KSG Director, Dr M. Jobson, and TPNP project leader, Professor T. Palmer, during which the ongoing injustice issues around water led to its adoption as a KSG theme (Palmer & Munnik, 2018). Data from the citizen science informant (Lipile, 2014) varies slightly in reporting how the *Water for Dignity* project emerged, compared to the official project reports from the larger partners (Weaver, 2019; Hamer *et al.*, 2018; Palmer & Munnik, 2018); however, negotiating, supporting and encouraging the emerging autonomy of the *Water for Dignity* project is well documented within official project reports and helps to reconcile these slightly divergent narratives¹²⁸.

Although the project reports are careful to make a distinction between the 'civil society research partners' and what I will term the 'professional researchers', I include both groups into the definition of 'citizen scientist' within this case study. Both groups of researchers are residents of Grahamstown, and both are working in sometimes distinct but related ways, to resolve complex and ongoing water-related issues in their home town. The professional researchers might be described as researcher-scientists enacting their citizenship; while the civil society researchers might be (and often are) described as community activists who sometimes engaged in research-informed activism as ways of enacting their citizenship. Within the project context, the activities and work led by the civil society researchers was called 'Water for Dignity'. The self-identified mission of this collective was "to change from just complaining, to becoming part of the solution" (Weaver, 2019; Palmer & Munnik, 2018:58).

128 This divergence is evidenced between the first published case description, based on a key informant interview with Lipile (2014), and this updated description, drawing on multiple sources, including a co-authored paper by Hamer *et al.* (2018), in which Lipile and the other citizen scientists were co-authors. In the official project reports, the ambivalence around autonomy of the *Water for Dignity* project, and the formal activities to support the strengthening of such autonomy are described in detail.

Water for Dignity (WfD)¹²⁹: Water for Dignity, as a project, emerged in April 2013, and was active under this project name until 2015 (Palmer & Munnik, 2018; Weaver, 2019). The WfD team consisted of five core members who were resident and practiced in Grahamstown East. The group self-identified under the name of 'Water for Dignity', and were intended to be autonomous and self-directed, although there were ongoing challenges with especially financial autonomy throughout the project lifespan (Weaver, 2019). The team directed and built their own internal capacity in relation to several areas of competence needed to inform project activities. They also engaged in a range of co-learning activities with university researchers (Palmer & Munnik, 2018).

Although the original invitation from the IWR was to collaborate on water quality related to microbial water pollution, the civic researchers argued for a shift in focus towards the more pressing water supply and quality issues related to household water security; project focus and practices were then developed to support this shift (Weaver, 2019). To support this shift, and in resonance with KSG, the WfD team adopted Paolo Freire's Education for Liberation Philosophy (see Palmer & Munnik, 2018, Freire, 1970). Citizens started with their situated and embodied knowledges of the challenges being faced by their community, and decided that something needed to be done about water provision - this became the starting point for the citizen science work enacted within the project.

7.3.4. Key Project Activities:

Four key areas of activity were described within the citizen science component of the project:

1. *Citizen Report Cards*: This involved the collection of house-hold data through a survey exploring water service delivery experiences of Grahamstown East residents. This survey was based on previous research developed by the IWR team for the Sundays River Municipality, but which were adapted, and in some ways, re-directed, by the citizen scientists (Hamer et al. 2018).

¹²⁹ Because the citizen science component of the project was fully integrated into the larger project in the context of Makhana Municipality, and specifically Grahamstown, attempts to separate out particular social and knowledge production processes become both inappropriate and problematic. To ameliorate this, I have attempted to limit descriptions and extracts of illustrative evidence to descriptions of work in Grahamstown; this is based on the case reporting across sources, which emphasise the interaction and iterative relationship between these two 'levels' of activity. Levels of activity are clarified in notes related to specific extracts, where relevant.

2. *Community Water Forums*: These took the form of water-related, neighbourhood-based hubs which served as information and communication pathways between the Grahamstown East residents and Makana Municipality.
3. *Installation of Emergency Water*: In this activity, large communal water storage infrastructure was installed on streets and in particular households to serve as emergency water supply during periods of water interruptions.
4. *School Water Forums*: This area of activity was concerned with supporting and strengthening the development of water conservation and hygiene, and contributing to catchment health.

Underpinning all of these activities were ongoing interactions (and attempted interaction) with Makana Municipality, with the aim of strengthening communication and improving water governance, as well as ongoing research, reflection and co-learning activities among and between the citizen scientists (Hamer *et al.*, 2018; Palmer & Munnik, 2018; Weaver, 2019). Other activities included leading water awareness activities, organising ‘water walks’ to expose, publicise and engage communities in discussions about water issues in urban streams and wetlands, and building a media scrapbook to keep track of water-related publicity (Hamer *et al.*, 2018; Palmer & Munnik, 2018).

7.3.5. Engaging a Diversity of Knowledges

Part of the strategy for the Water for Dignity project was a deliberate intention to engage a range of knowledges in the epistemic culture of the project. While not always clearly articulated, the intention to do so was foregrounded both within the project team, as well as through various project plans and reports. The following extracts evidence this intention.

Table 14: Articulating and engaging with various knowledge forms

Attempts to articulate and engage with diverse forms of knowledge	Illustrative evidence	Analytical notes
Embodied knowledges and scientific knowledges	<i>“The WfD team decided to monitor the incidence of diarrhoea amongst learners at township schools as a measure of possible microbial water pollution and on-site inspections of state of school sanitation. A record sheet for visits to Grahamstown East’s 23 schools was developed and a process of monthly visits was initiated” (Palmer & Munnik, 2018:67).</i>	Here, we have an indication of an attempt to work with embodied knowledges (diarrhoea as a way that the body knows something is wrong with the water). There is a specific intention to use this knowledge to intervene in a particular context - that of water health in schools.

Attempts to articulate and engage with diverse forms of knowledge	Illustrative evidence	Analytical notes
Basis of legitimization for knowledges within the project	<i>"The research reflected the fiercely held belief by the social activists [citizen researchers] that they needed to equip themselves with knowledge in order to be politically and socially effective" (Palmer & Munnik, 2018: 54).</i>	This extract highlights a particular basis of legitimization for whether knowledge is relevant or not within this project - here, the basis of legitimization is whether knowledge supports political and social efficacy.
Complexity-thinking as a driver of knowledge production and a basis of legitimization	<i>"At the core of the TPNP project was the need to reflect on and use emerging data to develop new ways of thinking about water management, that can accommodate the complexity and multiple dimensions, at different temporal and spatial scales" (Palmer & Munnik, 2018:59).</i>	As above, this extract evidences one of the bases of legitimization within the broader TPNP project - the ability to inform and accommodate complexity-thinking.
Articulating the relevance of local knowledges from a scientific research perspective	<i>"The KSGs involvement in this research project not only provides a direct window in the enduring injustices after apartheid, but also shows a keen grassroots intellectual energy and local knowledge of water service provision" (Palmer & Munnik, 2018:55).</i>	The catch-all concept of 'local knowledge' is used here to indicate a perception of the importance of a form of knowledge outside of the traditional bounds of scientific knowledge.
Community-generated people's sciences Articulating the relevance of local and situated knowledges and ancestral knowledges from a community activist perspective	<i>"Early on in the project, WfD expressed its commitment to a people's science, where the knowledge generated by communities, whether or not in partnership with academia, serves the interests of communities immediately and concretely. They said: "We expect respect for the expertise of people regarding the reality of their lives, and respect for the knowledge they have had passed onto them from our ancestors and from those around them. Khulumani believes that all people deserve the basic dignity of having their wisdom honoured. We believe that people are aware of the impact of water stress in their lives, and are able to provide data to academics that would be meaningful" (Palmer & Munnik, 2018:69).</i>	Here, the civic researchers articulate their assertion of the legitimacy of multiple forms of knowing; situated, ancestral, and lived experiences are recognised as legitimate forms of knowledge.
Attempting to frame more complex epistemologies	<i>"We suggest that this research practice produces a remarkable fusion of social justice concerns with a scientific and academic co-learning by students and academics" (Palmer & Munnik, 2018:53).</i>	Here, Palmer and Munnik seem to be attempting to articulate some form of epistemic interest that goes beyond the scientific and academic.
Internal governance knowledges in the form of distributed project management skills, leadership skills and diverse forms of communication skills	<i>"Researchers and NGO partners had formal training in research methods and project management. Although the WfD group had limited formal training they had equally valuable tacit skill-sets built through experience such as leadership, multi-lingual communication and networking. Different skill-sets were valuable for different aspects of the WfD CoP [Community of Practice] and were increasingly brought to bear as the CoP sustained their engagement, built relationships and developed their joint enterprise" (Weaver, 2019:88).</i>	Here, Weaver attempts to articulate a tacit system of knowledges that were significant in enabling common knowledge production in the project. One could categorise these knowledges as forms of governance knowledges, although this might be an oversimplification of a complex arrangement of knowledges.

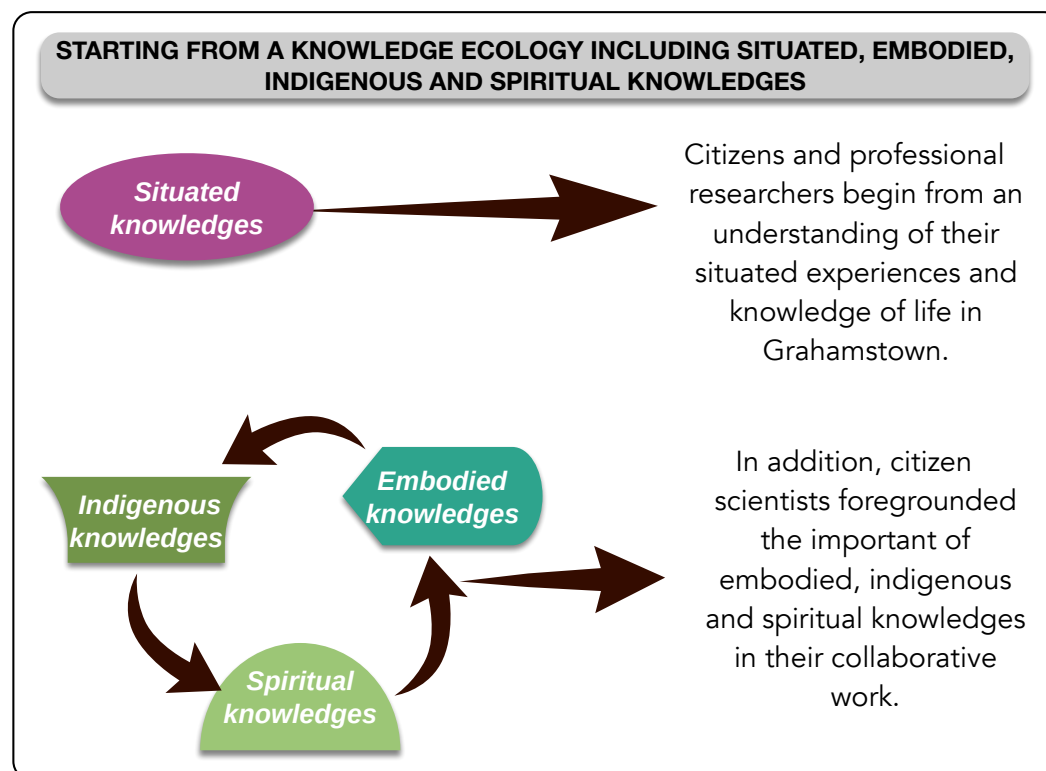


Figure 37: Starting from an ecology of knowledges which includes situated, embodied, indigenous and spiritual knowledges

7.3.6. Assembling an Ecology of Knowledges for the Project

Epistemic activity began through an already complex and established way of working with diverse knowledges from the IWR and KSG institutional cultures of practice. Situated knowledge was foregrounded almost immediately, and was accessed through a number of already developed project methodologies. The citizen scientists for their part, foregrounded embodied, indigenous and spiritual knowledges, and the professional researchers brought with them, a range of scientific methodologies and ways of organising knowledge. The below extracts evidence the mobilisation of these diverse forms of knowledge into an ecology of knowledges for the project.

Table 15: Recognising diverse knowledges at play within the Water for Dignity project

Knowledge Aspect	Illustrative evidence	Analytical notes
Working with situated knowledges in systematic ways	<i>"Meaningful findings derived from practice: Citizen Report Card (CRC) surveys revealed: water service delivery challenges in Grahamstown East, water tariff billing discrepancies, residents' enthusiasm to participate in water initiatives, residents' lack of basic water knowledge" (Weaver, 2019:115).</i>	Weaver describes the findings emerging from systematic engagement with the situated knowledges (collected in the form of report card data). i.e. Weaver is describing the application of scientific method to making one level of meaning from situated knowledges.

Knowledge Aspect	Illustrative evidence	Analytical notes
Scientific analysis of situated/contextual experiences	<i>"An analysis of municipal records, newspaper articles and readers' letters, and a review of recent literature were undertaken" (Palmer & Munnik, 2018:52).</i>	In this extract, Palmer & Munnik describe a range of sources which provide historical forms of situated insights and theoretical explorations of the context of water quality in Grahamstown. These situated data are engaged with scientifically.
Articulating an initial ecology of knowledges	<i>"The KSGs involvement in this research project not only provides a direct window in the enduring injustices after apartheid, but also shows a keen grassroots intellectual energy and local knowledge of water service provision" (Palmer & Munnik, 2018:55).</i>	Here, the authors, who are researchers from the IWR, articulate an initial ecology of knowledges, with particular focus on the value and relevance of local knowledges to the scientific research process intended for the project.
Evidencing situated knowledges and using situated insights to make meaning of social interactions	<i>"A narrative interviewing approach was employed, where stories of peoples' experiences were gathered" (Hamer et al., 2018:608). "In Vukani narratives show the various measures taken to ensure water at home during an outage" (Hamer et al, 2018:611). "These narratives voice the difficulties households faced in their attempts to have water problems dealt with by municipalities" (Hamer et al., 2018:612). "The narratives also provided insight into why people do or don't pay for municipal water" (Hamer et al., 2018:614).</i>	Here, Hamer et al. describe the process of scientific data collection, with a focus on evidencing situated knowledges within the Grahamstown East community, as well as illustrating how the research team began to make specific, situated meaning of the emerging data.
Engaging with the situated knowledges of communities	<i>"The WfD team sought a deep understanding of the water challenges experienced by people living in the Vukani township [Grahamstown East suburb]" (Hamer et al, 2018:608-9).</i>	This extract, again, illustrates the purposeful intention to draw on peoples' situated knowledges to inform their [the scientific and civic researchers] understanding of water quality issues in Grahamstown East.
Collecting scientific and situated data	<i>"They [WfD] decided to monitor the Matyana River from north to south once a month. They acquired mini SASS [sic] equipment for use on the Matyana River" ... "The WfD team have been equipped with a camera by IWR and have taken photographs to document water and sanitation issues that need attention" (Palmer & Munnik, 2018:67).</i>	Palmer & Munnik describe integration of data collection systems drawing on both established scientific protocols (MiniSASS), and systems of documenting contextual issues (in other words, a form of capturing situated knowledges in a scientifically analysable form).
A theoretical construct which seeks to engage ecologies of knowledges	<i>In the methodological descriptions of this case study, researchers describe the transdisciplinary approach adopted within the TPNP, which is a "reflexive, integrative, method-driven scientific principle aiming at the solution or transition of societal problems and concurrently of related scientific problems, by differentiating and integrating knowledge from various scientific and societal bodies of knowledge" (Lang et al. 2012, p.5)" (Hamer et al, 2018:606).</i>	Hamer et al. describe the intention to engage both scientific and other forms of knowledges in understanding the water story of Makana Municipality. Key here is the use of scientific knowledges as the legitimating systems of reconciling and eliciting various forms of knowledges.
Conceptualising historical and emergent situated knowledges	<i>"The project comprised two processes: interaction or attempted interactions with the municipality of Makana, and layered, iterative processes of learning by probing Makana's history, including its water infrastructure history. Makana residents' current experiences of water provision, as well as a number of initiatives aimed at immediate improvements of the situation, which, in themselves, were processes of learning and discovery" (Palmer & Munnik, 2018: 54).</i>	In this extract, Palmer & Munnik, describe a systematic and scientific process of engaging with both a historical analysis and emergent situated experiences of water quality in Makana Municipality.

Knowledge Aspect	Illustrative evidence	Analytical notes
Developing epistemic competence to work with scientific knowledges	<i>"Accuracy in data collection improved as the WfD members conducted more surveys, refined their survey method and learnt about the importance of rigorous data collection to produce reliable and representative findings" (Weaver, 2019:114).</i>	In this extract, Weaver describes the development of scientific research competencies within the Water for Dignity civic researcher team.
Recognising the significance and value of situated knowledges in resolving situated water challenges	<i>"The case study focused on building an understanding about Adaptive IWRM based on what people think and experience, and not making assumptions about how to solve problems in advance" (Palmer & Munnik, 2018: 54). [The case study refers to activities and outcomes including and beyond the WfD period of activity]</i>	Here, Palmer & Munnik highlight the central role of experience (as a possible form of situated knowledge) in developing an understanding of water quality challenges and possible responses.
Iterative learning through combinations of situated and scientific knowledges	<i>"Palmer and Munnik (2018) found that citizen participation in the Citizen Report Card process resulted in better local community understanding of water supply issues" (Hamer et al, 2018:616).</i>	This extract illustrates an iterative learning relationship between scientists (civic and professional), and community members, mediated through the interaction between scientific and situated knowledges.
Foregrounding a particular form of situated knowledge	<i>"They [WfD] also undertook to take care to ensure that women's views are well-represented, because women are often the most likely to be involved in the sourcing of water, as well as its distribution within the household, their input will be critical" (Palmer & Munnik, 2018:69).</i>	Different bodies within the same context have access to different situated knowledges. Here, a particular form of situated knowledge is being sought - that of women living in Grahamstown East.
Supporting management of systems of scientific knowledge production	<i>"A post-graduate student, Matthew Weaver, researching the role of civil society in grass-roots water resource management, assisted Water for Dignity in organisation, recording, and analysis of their data and results" (Palmer & Munnik, 2018:59).</i>	Supporting and strengthening scientific protocols and data management systems through researcher support.

Enactment of this ecology of knowledges was supported through project processes which enabled such knowledges to emerge and be recognised as valid and legitimate within the project context. Throughout the project lifespan, various mechanisms were leveraged to support the integration of diverse forms of knowledge into the epistemic culture of the project. These three extracts evidence this intention:

Learning workshops brought people of diverse expertise together and served as rich spaces for building the effectiveness of specific aspects of the CRC [Community Report Cards] practice (Weaver, 2019:92).

The Makana case study was initially designated to investigate microbial pollution of a local stream (Palmer & Munnick, 2018). However, this shifted to align with community priorities. The adaptation of the research focus was the first indicator of 'co-created, solution-oriented, transferrable knowledge (Hamer *et al.*, 2018:608).

In Makana there was a more active citizen role, where local concerned residents were involved in adapting questions and undertaking the surveys (Weaver, O'Keeffe, Hamer, & Palmer, 2017; Hamer *et al.*, 2018:605)

Although an ecology of knowledges was privileged within the project design and implementation, the extracts within the data table also indicate that the primary mechanism of legitimating such knowledges was through a process of reconciling them within western scientific forms of knowledge production.

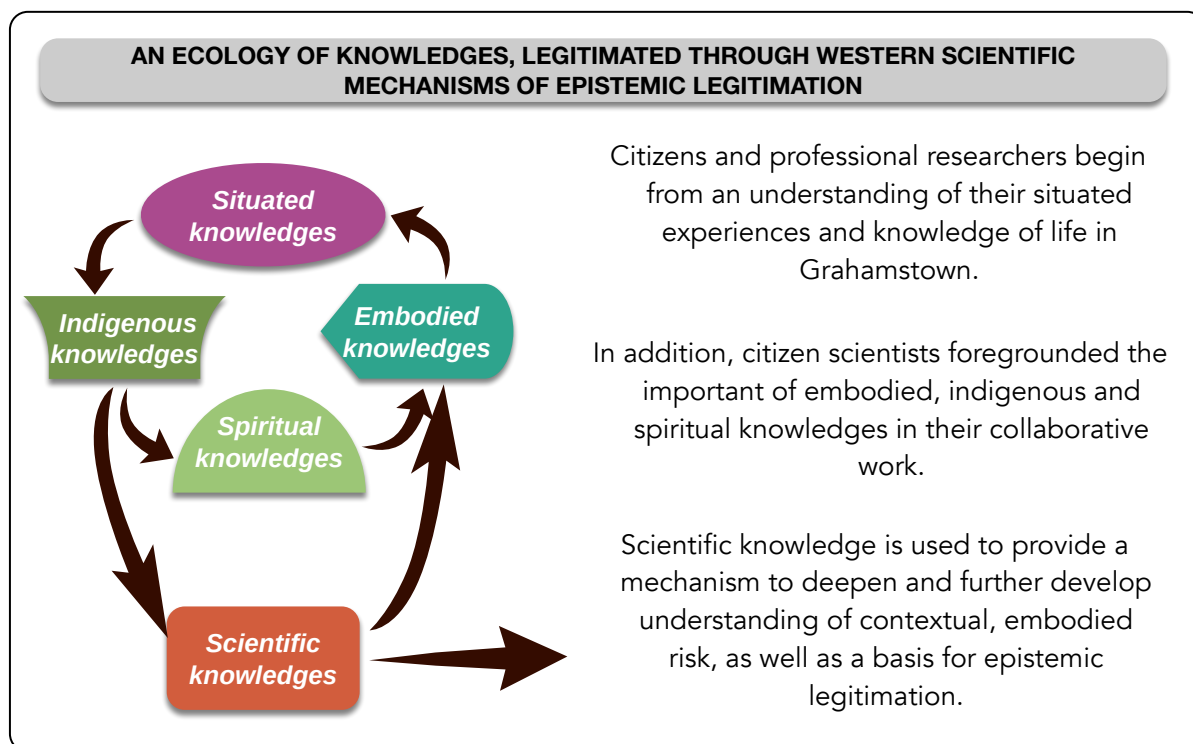


Figure 38: Scientific knowledge is used as a tool to deepen understanding, and to strengthen validity of, and formalise situated and embodied knowledges

7.3.6.1. Building knowledge that can be understood within municipal governance structures

While the first phases of the project proved to be relatively successful (collection and analysis of situated and embodied data), the project team were concerned about their lack of success in engaging the local municipality regarding their findings. Makana Municipality has been under public administration several times, and is considered to be one of the poorest run municipalities in the country. Several attempts to connect with, and access governance mechanisms within the municipality failed.

Water for Dignity attempted a number of times to engage with the local municipality, in order to establish a discussion forum (Community Water Forum), but they were not successful in obtaining municipal participation. (The local water forum emerged later in 2016)” ... “Working with local government was frustrating (Palmer & Munnik, 2018:65).

The relationship between MLM [Makana Local Municipality] and citizens is formally facilitated through ward committees” ... “many of the 14 wards do not have functional ward committees” ... “The resultant communication breakdown has alienated a large proportion of the community,

leading to dissent and the general lack of support for existing municipal processes (Weaver *et al*, 2017:405).

Although the need for community participation is enshrined in South African legislation such as the Municipal Services Act (No. 32 of 2000) and the National Water Act (No. 36 of 1998), the high frequency of service-delivery-related protests is one indication that the current service delivery is failing to meet the demands and expectations of citizens on the ground (Hamer *et al*, 2018:604).

At this stage, the work of KSG was foregrounded. They worked with the WfD project team to build capacity regarding municipal governance structures - a form of governance knowledge, but this time, from a participatory democracy perspective. One aspect of this work was to increase the team's governance knowledge of their local governance rights, and to build an understanding of the participatory democracy mechanisms within municipal governance structures. Another aspect was to support the WfD team to present data in ways that aligned with municipal formats, drawing on a civic rights framework. This process allowed citizens and scientists to take their findings to the municipality in ways that were understandable and translatable into municipal functioning.

The development of these particular forms of governance knowledge was then leveraged to inform a number of risk-responsive strategies including, for example, a) raising funding for the installation of communal water tanks to supplement erratic water supply, b) a research-led lobbying campaign that they took to the municipality to challenge poor water-related service delivery, and c) the establishment of water forums within the community to provide an ongoing space for engaging with community related to water issues. The following extracts evidence this process of building governance knowledge and translating epistemic outputs into formats visible within governance structures:

Table 16: Integrating governance knowledges into the ecology of knowledges

Governance Knowledge Aspect	Illustrative evidence	Analytical notes
Developing epistemic competence in relation to scientific, governance and situated knowledges	<i>"They [WfD team] built their own capacity in a number of research and learning settings: internally, as part of the research project team, and in interaction with university academics in a regular transdisciplinary seminar. They made sure that they understood the responsibilities of local government through a study and discussion of water policy and legislation. They undertook a report card data collection exercise, in which community members were asked about their experiences and perceptions of water services in Grahamstown. The results were analysed with support from academics" (Palmer & Munnik, 2018:65).</i>	This extract illustrates various ways of building diverse forms of competence in relation to scientific, governance and situated knowledges.

Governance Knowledge Aspect	Illustrative evidence	Analytical notes
Developing communication mechanisms regarding water supply and quality	<i>"The involvement of the University project MobiSAM, a mobile phone-based water communication project became extremely important. The TPNP researchers connected MobiSAM and the Municipality" (Palmer & Munnik, 2018:57).</i>	Here, there is evidence of using technology to translate situated knowledges (faults reported by citizens through MobiSAM) into applied governance knowledge (reporting of faults and issues in a format and through a system legitimated within the municipal governance structure).
Developing epistemic competence in relation to scientific and governance knowledges	<i>"The IWR project partners contributed with their experience in conducting rigorous scientific research in terms of methodology and data management and analysis. The IWR conducted data collection, management and analysis Learning Workshops to build the researcher capacity of WfD members. However, the KSG (acting as the WfD team) already had the intention to expand their own knowledge in terms of legislation, what their rights were, what the obligations of the municipality were, as well as the scientific knowledge they needed for monitoring the river" (Palmer & Munnik, 2018:66).</i>	Similar to the extract above, this extract illustrates both the planned, facilitated development and strengthening of scientific knowledge production skills, and the intention to develop governance knowledges - especially as regards civic rights and municipal obligations.
Building governance knowledges and relating it to situated knowledges	<i>"The team identified a number of problems in the municipality's provision of water services which corresponded to the everyday experience of many residents in Grahamstown East suburb" (Palmer & Munnik, 2018: 54).</i>	Translating between governance systems and situated knowledges, and establishing correlations. This process evidences an analysis of situated experiences in relation to governance structures.
Complex engagements with governance systems - representing emergent knowledge	<i>"This shows the University as a powerful actor but also dependent on the municipality for its water supply. That this structural situation had an impact on the research project was shown when members of the research team published in the local press an alternative point of view to that of the University as an institution" (Palmer & Munnik, 2018:55).</i>	Here, Palmer and Munnik illustrate the complexity of being located within and doing research in the same municipality; the extract carefully points to the leveraging of governance knowledge as a municipal-dependent institution, as well as the ethical imperative to report potentially 'undiplomatic' findings about the municipality.
Doing, and emergent learning through historical mapping, developing competences to engage with governance systems, and situated knowledges	<i>"The project comprised two processes: interaction or attempted interactions with the municipality of Makana, and layered, iterative processes of learning by probing Makana's history, including its water infrastructure history, Makana residents' current experiences of water provision, as well as a number of initiatives aimed at immediate improvements of the situation, which, in themselves, were processes of learning and discovery" (Palmer & Munnik, 2018: 54).</i>	This extract articulates a particular process of accessing historical situated knowledges and current situated knowledges from community members, while also reflexively building on-going situated and scientific knowledges, and taking action in context iteratively as insights are gained, as a process of developing one form of governance knowledge.
Institutional forms of governance and developing knowledges to navigate them within project contexts	<i>"WfD members learnt through repeated practice, learning by doing, to navigate the bureaucratic structures of the IWR that enabled them to perform certain aspects of their practice" (Weaver, 2019:114).</i>	This extract indicates a different form of governance knowledge to the majority of extracts in this section [which refer to governance knowledges as related to state functioning]; here civic researchers develop a form of institutional governance knowledge.

science approaches geared towards strengthening participatory democracy, and the complexity of issues which need to be managed and foregrounded to support stronger systems of cognitive and distributive justices.

7.3.8. Mobilisation of Knowledges in Response to Social-Ecological Risk

The above tables of evidence once again, illustrate a complex and responsive ecology of knowledges being mobilised in response to situated social-ecological risk. They also demonstrate a sophisticated series of processes leveraged to build common knowledge. The knowledge produced within this ecology was demonstrably mobilised in a number of different ways, including:

- As a mechanism to build civic awareness and a range of knowledge literacies (such as scientific, and governance literacies);
- As scientific knowledge production process;
- As a way to engage and enact various forms of participatory democracy, and in some ways, more radical forms of democracy; and
- To inform targeted situated interventions and community actions to mitigate or manage some aspects of risk.

Leveraging these knowledges into an ecology with each other enabled citizens to work with their experiences related to a specific situated risks in multiple ways; first through increasing validity and systematic rigour of their findings; secondly, through being able to translate what they found into knowledge that was understandable within a municipal system; and thirdly, by enabling a range of contextually applied responses to social-ecological risk. In addition, knowledge produced was translatable into a scientific system of rigour, and contributed to the expansion of 'matters of fact' and, especially to the articulation of 'matters of concern' within the larger scope of work being produced within the IWR. The following extracts illustrate project team reflections on the effectiveness of mobilising this ecology of knowledges, and the related processes of commoning in relation to a specific set of situated social-ecological risks:

[T]his case study is somewhat exceptional in the ongoing and close contact between the civil society activists and the university students and academics, which created opportunities for both sets of actors together to probe issues of the politics of knowledge (although in the case study it was not named as such) (Palmer & Munnik, 2018:53).

The systemic approach of the case [of water supply in Makana Municipality] has provided a realistic point of departure. Technical responses alone to Adaptive IWRM challenges have not been successful in resolving the challenges faced in the Makana Local Municipality (Palmer & Munnik, 2018:69).

Within the Makana Local Municipality (MLM), institutional development had not progressed to the establishment of water management institutions such as catchment management forums, in which civil society could participate. The lack of formal engagement platforms for WfD to engage in water governance processes limited the opportunity to explore the beneficial roles that CSOs¹³⁰ could play in such engagement platforms (Weaver, 2019:22).

The TPNP researchers confirm that peoples' analytic outcomes [possibly meaning their knowledge contributions about their experiences with water supply and quality issues] were useful and were deepened and developed in the course this project. People were happy to share what they knew and to learn how water systems work biophysically and societally. Broad-based participation was important during the entire scientific process, contributing to democratising concepts like hydrology, climatology and water resource management, so that people can context, create, debate and discuss in order to participate meaningfully in future water resource management (Palmer & Munnik, 2018:69).

7.3.9. Implementing State Mandates vs Participatory or Radical Democracy

This case study illustrates an attempt by citizen scientists (including professional scientists who are resident in Grahamstown) to engage in informed approaches to participatory democracy. The case also shows that in spite of State 'recognisable' formats for such participatory inputs, information or even robust contextual and scientific knowledges, were insufficient to mobilise those municipal vehicles designed to enable and support this form of participatory democracy. This spurred citizen scientists into what might be considered a form of radical democracy, where they adopted an oppositional or challenging stance against municipal management structures, in addition to bypassing municipal structures through local, adaptive problem-solving.

There is also evidence of compromise and negotiating some reduced levels of service in order to set in place emergency mechanisms to support water provision - evident through the installation of emergency water tanks in various communal areas. The supply of the water tanks was funded through corporate funding; the municipality eventually agreed to water supply to these tanks (although later evidence indicates that this agreement was never fully honoured, and continues to be challenging in terms of basic water supply and maintenance). The tanks, while meeting an emergency-level need for a reliable water supply to the area, also simultaneously mask the greater failure of the municipality to meet its mandated function of supplying a minimum standard and quantity of usable water for each and every citizen resident in

¹³⁰ Civil Society Organisations

Grahamstown East. Again, there is the potential for State mandates and responsibilities to be divested onto citizens, rather than a stronger articulation of functional participatory or radical democracy.

The case demonstrates a need for the development of more robust systems of governance which are geared towards enabling and supporting participatory and radical democracies so that citizen contributions become both visible and valued within the democratic infrastructure and spirit of governance.

7.3.10. Produced Nonexistence vs Epistemic and Distributive Justices

Unsurprisingly, considering the short lifespan of the WfD project, and the intentions to deepen cognitive and distributive justices within the project, the project failed to meet all the outcomes the project team had hoped it would. The lack of financial sustainability - both for the project, and especially for the citizen scientists remained a challenge and ultimately rendered the project unsustainable for project team members other than professional researchers. This is an ongoing challenge within citizen science initiatives, and points to deep issues of distributive justice especially. As Hammer *et al.* reflect,

[a]t the end of three years WfD citizen-researchers had collected data that later lent weight to the formation of a local water forum. But individually they no longer participated in participatory water opportunities, and probably experienced demotivation. This raises the vexed question of extractive research. Over three years, academic outcomes exceeded citizen researcher benefits. However, gathering and understanding the lived experiences of citizens informed government responses to water interruptions ... However, communication of citizen voice did not in itself effect a shift in the experience of water interruptions (Hamer *et al.*, 2018:617).

And,

[I]n Makana, co-location of the municipality and the research team meant continued engagement was possible. Researchers facilitated the formation of a Water Management Forum, with the support of both the municipality and the Department of Water and Sanitation. The focus comprised volunteers from a wide range of stakeholder groups and has met regularly for two years. However, the WfD team did not actively join and participate in the forum. This draws attention to the linkage between their activity and the stipend, and the failure of the engaged research process in enabling the team to move into a water-related entrepreneurial phase (Hamer *et al.*, 2018:615).

The tabulated extracts also indicate a clear intention, supported by a range of practices, aimed at enabling and supporting epistemic justice. Both the citizen scientists and professional scientists indicated the value of this approach, both in terms of mutual recognition, and also in terms of the value for knowledge production and applied practices. These included accredited, peer-review publications, but excluded the cumulative benefits of such publications which are

available to professional communities of scientists. Also, knowledge work was still primarily legitimated through western scientific processes of rigour:

Participating in formal community engagements such as CRC¹³¹ surveys, School Water Forum days, Community Water Forum meetings and Emergency water meetings [sic]. Reification of situated practice by producing and reflecting on codified projects outputs e.g. CRCs, CRC reports, media articles and practice stories, which consolidated the knowledge of lived experiences, providing empirical findings (Weaver, 2019:115).

In relation to the perception of the value of WfD practice findings, Weaver describes the following as learning mechanisms: "Inclusion of results in recognised academic deliverables to the Water Research Commission (Palmer & Munnik, 2018), and presentations at national and international conferences, symposiums and formal dialogues" (Weaver, 2019:115). Although Weaver attempts to reconcile WfD practices within legitimated academic terms, it should also be noted that each of the data sources referenced in this case study attempted to describe WfD knowledge production activities as legitimate outside of, and beyond academic forms of knowledge legitimisation. For example, Weaver also notes that, "[p]ractice outputs were perceived as meaningful by the Khulumani Support Group and academic partners at the Institute for Water Research" (Weaver, 2019:115).

7.3.11. Water for Dignity Case Conclusion

This case study offers insight into how more robust and just ecologies of knowledges might be convened, and how systems of participatory and radical democracy might be strengthened. During interviews and informal conversations with various project team members, participants were always careful to consider and articulate both the successes and challenges of this approach to citizen science. This approach is distinct from data-driven citizen science approaches which foreground scientific protocols to govern epistemic activity. Rather, the epistemic approach adopted by WfD appears to be more responsive to situated risks, and the need to strengthen cognitive and distributive justices - both within the project itself, as well as within the situated context of water supply in Grahamstown East. As the evidence illustrates, although project conveners and the project team, intended to foreground issues of cognitive and distributive justice, and did so at conceptualisation levels, justice issues still persisted in applied practices and remained problematic throughout the project lifespan. Even so, reports and peer-reviewed papers evidence some substantive gains in terms of epistemic justice.

¹³¹ Citizen Report Card

7.4. Illustrative Case Study 3: ToadNUTS Project

This citizen science project is focused on protecting the endangered Western Leopard Toad, a species endemic to a small region in the Western Cape of South Africa. In urban environments, roads and verge barriers, as well as various other human structures, have become significant features of the Western Leopard Toad's habitats. They also pose significant obstacles to the natural migration patterns of the toads, especially during breeding seasons, during which time increased road traffic resulted in substantial numbers of toad deaths annually (van Wyk, 2015).

7.4.1. The Western Leopard Toad Conservation Committee (WLT-CC)

As with both case studies above, this 'citizen science' project forms one component of a larger system of activity, and is intertwined with multiple programmes in ways that make it difficult to distinguish the 'citizen science' aspects of activities from other aspects. The most significant formalised set of relationships are convened through the Western Leopard Toad Conservation Committee. The committee is comprised of a range of representatives from various organisations. Representatives include volunteer groups from a range of neighbourhoods, the City of Cape Town (municipal authority), Overstrand Municipality (municipal authority), Cape Nature (provincial biodiversity authority), South African National Parks (national biodiversity authority), the South African National Biodiversity Institute (national biodiversity management agency), Table Mountain National Park, and the Nature Conservation Corporation (an environmental consultancy) (WLT-CC, 2019; van Wyk, 2015). The committee meets quarterly.

In November 2009, the South African National Biodiversity Institute (SANBI) organised a stakeholders meeting, bringing together all parties interested in the conservation of the Endangered Western Leopard toad. The objective was to assess conservation actions throughout the range of the species, as well as to plan a co-ordinated effort for future conservation activities. A major result of the meeting was the formation of the Western Leopard Toad Conservation Committee (WLT-CC), which constituted members from each of the extant volunteer groups as well as representatives from the official conservation bodies: SANBI, CapeNature, South African National Parks and the City of Cape Town. The goal of the WLT-CC is to reduce the threat level of the Western Leopard Toad through co-ordinated conservation actions from all stakeholders (Measey, Dorse & Faraday, 2012:15).

The committee was formed in 2009, with the role of convening and overseeing knowledge production and applied conservation activities related to the Western Leopard Toad species, including volunteer work, research, monitoring, and fund-raising. It brings together a range of stakeholders with diverse skills across a range of activity systems (WLT-CC, 2019; Young, 2010). As van Wyk (2015:54) notes, "[t]he intention of the once a quarter meeting is to shape a multi-

stakeholder conservation perspective". The committee spear-headed the articulation of a biodiversity management plan for the Western Leopard Toad, which has since seen implementation across various organisations and groups (WLT-CC, 2019; Measey, 2011).

7.4.2. A Volunteer Group: ToadNUTS (Noordhoek Unpaid Toad Savers)

The citizen science activities that are at the heart of this case description relate to one particular group of citizen scientists from the Noordhoek area called ToadNUTS. A number of other citizen scientist groups are also active in neighbouring areas, along the species range. ToadNUTS was started in 2007 by Alison Faraday and Suzi J'Kul, who are both residents of Noordhoek, in the Western Cape, neither of which are scientists by profession. Together, Faraday and J'Kul mobilised a group of volunteers to save leopard toads from becoming roadkill in their community during the breeding seasons (Faraday, 2014; van Wyk, 2015). The group is formally established under the organisational banner of the NGO, Noordhoek Environmental Action Group (NEAG).

The group currently participates in a range of activities, all of which are related to ensuring the ongoing survival of the Western Leopard Toad. To begin with, the ToadNUTS focus was simply on preventing road mortality rates by mobilising groups of volunteers to patrol key roads during rainy nights during breeding seasons and rescue toads attempting to cross the road to and from breeding ponds (Farham, 2013; Faraday, 2014). Volunteers would collect the toads and carry them across the road in the direction they were travelling. This system of activity eventually also included putting up seasonal signage to alert drivers that they were entering a stretch of road with 'toad traffic'.

Due to the low resource availability within ToadNUTS, only a particular demographic of volunteers are able to participate in especially the patrolling activities, which still form the core volunteer activity for the group. Volunteers need to have access to a vehicle, and be able to self-fund the fuel cost of patrolling. They also need to be physically able to drive, hop in and out of vehicles, and quickly collect and move toads out of danger. While there are a range of other activities that volunteers can participate in, this demographic describes the majority of ToadNUTS volunteers (Faraday, 2014; van Wyk, 2015).

In 2013, after a volunteer was rammed by a drunk driver during an attempted toad rescue, the coordinating team realised they needed to identify less risky systems of toad rescue (Faraday, 2014; Farham, 2013). The citizen science group developed a partnership with the Endangered Wildlife Trust (EWT) - a larger, well established NGO, who supported them to access funding to construct road barriers. The coordination team got the idea for road barriers from international articles on wildlife protection strategies, and engaged in a process of research to investigate diverse barriers and related solutions (Faraday, 2014). Realising that the systems being used in other countries were too expensive for a small community group to fund, they devised a low cost option, and trialled it in 2013 (Faraday, 2014; Farham, 2013). The solution consisted of constructing low barriers along road verges, using coloured netting. The barriers stopped toads from crossing the roads, and instead, directed them into a series of bucket pitfall traps. Buckets were emptied at least twice a day by volunteers who would carry the toads (and other wildlife landing in the buckets) across the road (Faraday, 2014; Farham, 2013). The intervention resulted in a 100% reduction in mortality from motor vehicles (Farham, 2013). A long-term goal of the group (and now also the WLT-CC) is to establish a system of affordable conservation structures, such as under-road wildlife tunnels and directing culverts (Faraday, 2014; van Wyk, 2015).

In addition to the 'tloading' (a turn of phrase that volunteers use to describe this activity), the group also engaged in a number of other activities to reduce toad mortality rates within the community, including (for example), designing a low-cost 'toad saver' system for swimming pools to prevent drowning (van Wyk, 2015; Farraday, 2014).

Citizen science activities include:

- Road patrols during breeding seasons to rescue (and record data on) migrating toads;
- Engaging in advocacy to establish and protect the rights of the leopard toad for protected habitats and state passage during migrations to and from breeding ponds;
- Running education programmes for schools and local residents about the needs of toads living in their gardens;
- Assisting concerned residents with home support visits and toad rescues, where necessary;
- Fund-raising for ongoing conservation work;
- Raising ongoing awareness about conservation concerns through media;
- Recruiting and training volunteers in a number of suburbs along the peninsula;
- Contributing to EIAs and municipal management systems (through the WLT-CC);

- Working with members of the public to toad-proof swimming pools and secure home environments for toad-friendliness (Faraday, 2014; ToadNUTS, 2019).

Essentially we're looking at saving the species from extinction, so we do whatever is required for that (Faraday, 2014).

The conservation efforts to protect this species clearly illustrate the important role that citizen scientists play. These active volunteer groups in the Cape Peninsula (who during the breeding season even patrol the main roads at night to protect the toads that are crossing to the breeding sites) make a valuable contribution to this flagship urban conservation project (Young, 2010:21).

One herpetologist was very complimentary saying that, "if it was not for the world of the Toad NUTS, the toads would have moved from endangered to critically endangered in the last seven years" (van Wyk, 2015:66).

7.4.3. Articulating an Ecology of Knowledges for the Project

A preliminary articulation of the ecology of knowledges evident in the ToadNUTS project is presented below.

7.4.3.1. Evidencing Scientific and Situated Knowledges

The two dominant aspects of this project are the collection of robust scientific data, and timeous intervention into local contexts. For the citizen scientists, the latter is of greater priority, and requires a robust system of situated knowledges which are mobilised towards direct, risk-responsive strategies. Such strategies are innovated as risks are identified, and are context and season-specific. Scientists within the project have an understanding of which scientific protocols should be implemented for the collection of robust species monitoring data, while citizen scientists have developed a range of situated knowledges which are leveraged for targeted localised interventions and toad rescue strategies. The following tables evidence the presence of these two knowledges within the epistemic culture of this project.

Table 17: Illustrative evidence of an ecology of situated and scientific knowledges

BUILDING SCIENTIFIC & SITUATED KNOWLEDGES	Illustrative evidence	Analytical notes
Building situated knowledge for toad and volunteer safety	<i>"Learning how to patrol in the field is very important as there are certain protocols to observe regarding reflective clothing, driving style, lights and signs on vehicles, safety procedures when stopping on a road and handling the toad" (van Wyk, 2015:51).</i>	Here, the extract illustrates the development of situated knowledges to safe guard both toad and volunteer safety during monitoring activities.

BUILDING SCIENTIFIC & SITUATED KNOWLEDGES	Illustrative evidence	Analytical notes
Scientific monitoring protocols	<i>"Data is to be recorded of each toad, including a GPS waypoint of the location, a clear photograph of the dorsal or back of the toad from an arial view, a measurement of the length of each individual and the weight of each toad" (WLT-CC, n.d.).</i>	Again, the extract describes a scientific protocol being used for monitoring activities.
Convening epistemic and monitoring cultures in response to local environments	<i>"[I]t is for the residents in a particular area to respond to the need and mobilise an active volunteer group in their own area in a way that works for them and their unique historical and social composition, circumstances, problems and resources" (van Wyk, 2015:59).</i>	Situated knowledges are used to organise and manage local volunteer activities, and vary from area to area. This demonstrates one significant role of situated knowledges within this epistemic culture.
Legitimizing epistemic activities through scientific systems	<i>"Many consider information published in a peer reviewed journal as a qualifier of new knowledge. The association with EWT has also created associations with three scientists who made input to the report produced by ToadNUTS. This helped to guide the group in writing in a way that is acceptable to the scientific fraternity" (van Wyk, 2015:66).</i>	Scientific knowledge is used as a basis of legitimation for epistemic activities within the project. The extract also evidences building scientific literacy skills in order to represent epistemic findings in ways that are recognisable within scientific systems.
Development of a scientific database for leopard toads as a knowledge commons	<i>"[data extract: ... the scientist kept saying that he can't believe the data that we have been collecting for so long, the data is fantastic, why has no-one used it? It was such a breath of fresh air for us. The data can be used for research. He was very excited about using the data and the barrier data to generate funding and really start investigating leopard toads as a research project and he felt strongly that he could use our data to do that]. The scientist also advised them on how to improve their methodology and is available to advise them should they have questions. The Toad NUTS facilitators feel that because of their intimate knowledge of the Western Leopard Toad in the local environment, they were providing information to the scientist that was new and unique" (van Wyk, 2015:65).</i>	Here, the extract evidences a scientific knowledge commons co-produced by citizen scientists. Again, there is evidence that the scientific knowledge being produced by citizen scientists can be leveraged for further knowledge production, in addition to substantiating funding grants and mobilising further toad conservation resources. Also evidenced is the important role of situated knowledges as contributors to the building of scientific knowledges.
Scientific monitoring protocols	<i>"There is a tried and tested technique called "capture-mark-recapture" through which we can model population size. Happily, we don't have to mark Western Leopard Toads as they - like Leopards - have their own individual markings on their backs - all we need is a clear photograph of the back, and some sophisticated computer ID recognition software, and we can estimate how many toads are in each population" (WLT-CC, n.d.).</i>	Here, the description shows the use of an established scientific protocol for monitoring purposes.
Elevation of scientific knowledges above other forms of knowledge	<i>"[O]nly scientific studies of subsequent breeding success after these interventions will tell us just how successful these efforts are. This is where citizen science comes up against its greatest limitation. What is now desperately needed is intervention from the scientific community to guide further initiatives and do the research required to accurately gauge the success of other conservation efforts" (Farham, 2013:21).</i>	In this extract, scientific knowledges are clearly elevated above other knowledge forms, and specifically, scientific knowledges produced by professional scientists, rather than citizen scientists. Note that Farham is a professional scientist.
A knowledge commons for Western Leopard Toads	<i>"We have got data going back to ... 2008 ... so far our data has really been used by people doing studies ... we are happy to share the data ... to give it out ... I feel it is a hugely untapped thing ... it takes an enormous amount of effort to collect all this data and it's not really being used enough" (Faraday, 2014).</i>	A volunteer describing the limited use of scientific data within the knowledge commons generated by volunteers.

BUILDING SCIENTIFIC & SITUATED KNOWLEDGES	Illustrative evidence	Analytical notes
Scientific monitoring protocols	<i>"A Western Leopard Toad is photographed dorsally with a scale (ruler). The dorsal patterning of the toad is unique enabling automated identification to search hundreds of images for a match. Building up a database of such images over many years will enable Capture-Mark-Recapture information to be used for population demographic estimates" (Tolley et al. in Measey, 2011:39).</i>	Again, the extract describes a scientific protocol being used for monitoring activities.
Managing data collection on the ground - competing priorities between scientific data collection and toad protection	<i>"There is agreement concerning patrolling methodology which is uniformly practiced. Dead toads are scraped off the road with an egg lifter and thrown into the vegetation on the side of the road so that these are not counted more than once. Previously 'flatties' were collected in plastic bags and given to the WLT-CC chair for possible future DNA analysis. All these incidents are noted on a data sheet and called in, texted or emailed to the group co-ordinator at the end of the evening. Toad NUTS volunteers communicate their experiences briefly on WhatsApp [instant messaging application]" (van Wyk, 2015:48).</i>	This reference evidences the implementation of a scientific protocol for monitoring dead toads, and its adapted translation into situated practice.
Ongoing development of situated knowledges	<i>"In the field, patrol teams may have ad hoc meetings when passing to discuss what they have found where, where they have been, where they will be going etc, to co-ordinate their patrolling efforts. This allows members to deliberate with others to make decisions in real contexts" (van Wyk, 2015:68).</i>	This extract demonstrates the ongoing development of situated knowledges in response to on-the-ground conditions, and their influence in shaping monitoring activities.
Facilitating contextual knowledges through communication tools which enable real-time communication	<i>"The WhatsApp communication also allows a volunteer or patrolling team to tap into the collective knowledge base if they have a question. A type of virtual deliberation is possible and a collective decision can be made concerning a real problem encountered in the field by a patroller even if that person is on their own physically" (van Wyk, 2015:68).</i>	This segment illustrates one tool used to facilitate commoning - one that is responsive to the more rapid temporality required in building situated knowledges (compared to the more prolonged temporalities enacted in building scientific knowledges, for example).
Potential for situated knowledges to enhance the rigour and legitimacy of scientific knowledges	<i>"We invited Professor Michael Cherry - now he did the original study back in the '80s on the Leopard Toad ... he was saying, you know I think basically, you guys [TOADNUTS volunteers] know more about this animal than I do, but let me tell you about what I know', and back in the '80s the assumption was that these toads ... they're explosive breeders, and they bred between three and eight nights in the breeding season. Now we [the volunteers] absolutely know that's not true, because we can have four or five peaks within a season ... so what he did was he went down to the pond - he camped there, and he watched the toads come, and he did finger clippings to record, and then he went back the second year, you know. And then when they left, he left, 'cause he's not from the area ... so I do feel we are contributing in a different way to science because we live here, we're doing it for many many hours than somebody who's been doing a study would be able to" (Faraday, 2014).</i>	This extract demonstrates the contribution of situated knowledges in refining, strengthening and increasing the rigour of scientific knowledges. It demonstrates the erroneous assumption that scientific knowledge contains a more superior rigour to situated knowledges.
Inter-relations between situated knowledges and building robust scientific knowledges	<i>"Toad NUTS members learn from spending much time being in the field observing toad behaviour and interpreting what is known (form of disciplinary knowledge) about the toads in the local environment. The situatedness of learning is key to the Toad NUTS expertise" (van Wyk, 2015:70).</i>	Here, van Wyk points out one way in which situated and scientific knowledges are co-constituting in relation to this particular epistemic culture of toad conservation.

BUILDING SCIENTIFIC & SITUATED KNOWLEDGES	Illustrative evidence	Analytical notes
Inter-relations between situated knowledges and building robust scientific knowledges	<i>"The observations made during the first two years were summarised in a report, titled the Final Toad Breeding Report Aug 2008, which details facts of toad movements in the local context not known before. [data extract: Over the peak period of 9 nights there were toads on the roads every night (100%), which is why this period was identified as the peak period. For the main season of 39 nights, toads were on the road on 21 nights (54%). Rain was a very important factor in the migration of toads (for example the 'early bird' start to the season on 19 June, the actual start of the season on 27 July, and the start of the peak period on 13 August, were all rainy nights). However, it was clearly not the only factor. This pattern appears to indicate that once the toads start the main migration they do not stop just because it is not raining]. It is meaningful because not only does it allow for an informed or reasoned practice it brings an expertise of local experiences that is defensible"</i> (van Wyk, 2015:71).	Again, this extract illustrates the integrated nature of situated and scientific knowledges - specifically the important of situated knowledges in building robust scientific knowledges, and eventually, in informing reliable and locally appropriated applied conservation actions.
Inter-relations between situated knowledges and building robust scientific knowledges, and informing local monitoring and rescue actions	<i>"This information shows that patrollers know that toads move after dark in winter (from 6pm—and that the season is likely to occur from mid-July but this is dependent on rainfall. If it is a dry season, movement will be delayed, [data extract: However, if there has been no rain for a week or more, the toads may start moving in dry weather. In a period of roughly 42 nights, the toads will probably move on half of those nights]. This quote is loaded with information on what volunteers have learnt while doing patrolling, being in the outdoors with the toads, observing and finding out how toads respond to different conditions on different days"</i> (van Wyk, 2015:72).	Here, once again, the extract demonstrates the interconnection between situated and scientific knowledges, and how these are combined to inform local actions, monitoring schedules, and future conservation measures.
Protocols for building situated knowledges	<i>"This role [scouters] would require volunteers to monitor the streets from their homes and perhaps even take a drive through the roads to check if there is any first sign of toads moving in the streets"</i> (WLT-CC, n.d.).	This extract demonstrates one protocol being implemented for the development of situated knowledges. Scouters inform and initiate the monitoring season in each location.
Concept-building and concept-translation between situated and scientific processes of knowledge-building	<i>"Toad NUTS use terminology (often scientific) that is specific to their practice for example, amplexus (breeding embrace) and gravid (with eggs) females and shorthand terms such as 'hopper' (frog), 'flatty' (dead toad), and 'bucket run' (patrolling a stretch of the barrier intervention). Members use shorthand in the WhatsApp communication like SV (Sun Valley) or LM (Lake Michelle) to denote places or areas where they patrol"</i> (van Wyk, 2015:50).	This extract demonstrates what Edwards (2011) describes as concept-building and concept translation, as processes required for building common knowledge.
Building integrated scientific and situated knowledges.	<i>"Volunteers need to be able to identify the toads, understand the nature of their breeding season, know what weather patterns trigger the mass movement of toads, know where their breeding ponds are in the local landscape and the roads that they have moved on in the past to reach the breeding ponds"</i> (van Wyk, 2015:51).	This extract indicates the interactive use of situated and scientific knowledges being mobilised for toad monitoring and conservation efforts by citizen scientists. Neither the scientific nor situated knowledges alone, are sufficient for successful 'toading'.

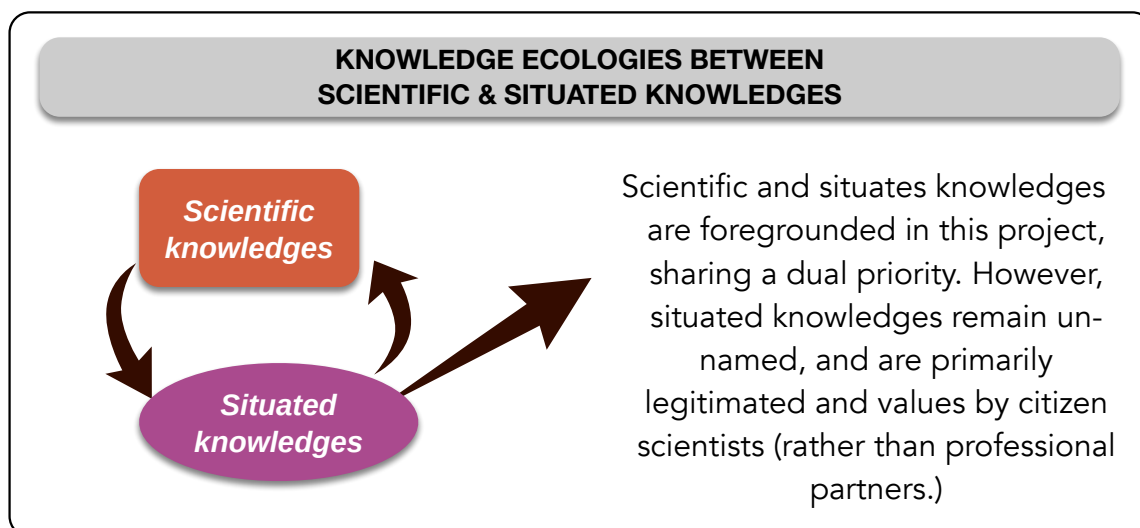


Figure 40: Using scientific knowledges and situated knowledges to drive and inform applied conservation actions and responses to situated risks.

The above extracts evidence the development of both scientific and situated knowledges in response to a range of risks to the Western Leopard Toad. They demonstrate an iterative relationship between the two forms of knowledges, towards a range of goals - all contributing to the conservation of the toad across scales and temporalities.

7.4.3.2. Integration of governance knowledges into the ecology of knowledges

In addition to scientific and situated knowledges, which might be considered the privileged knowledges within this ecology, both professionals and citizen scientists within the project have also developed diverse forms of governance knowledges. Particular governance knowledges operate at different scales, and within different State institutions. Professional scientists have particular pathways of interaction with governance systems compared to the pathways and strategies for interaction available to citizen scientists. Regardless of scale or formality, the below extracts evidence the important role of mobilising governance knowledges in toad conservation across scales.

Table 18: Illustrative evidence of governance knowledges

BUILDING GOVERNANCE KNOWLEDGES & SYSTEMS	Illustrative evidence	Analytical notes
Longterm translation of scientific data into governance mechanisms and applied conservation	<i>"BMPs [Biodiversity Management Plans] require conservation recommendations that are firmly based on scientific research. Conservation research takes many years to complete in order to provide sufficiently detailed information on which to base policy decisions"</i> (Young, 2010:21).	This extract points to the formalised, albeit prolonged, process of translating scientific knowledges into governance knowledges and applied conservation practices.

BUILDING GOVERNANCE KNOWLEDGES & SYSTEMS	Illustrative evidence	Analytical notes
Drawing on legal structures and leveraging governance knowledges to inform and legitimate local conservation actions	<i>"The Western Leopard Toad (Amietophrynus pantherinus) is a protected wild animal in terms of the Nature Conservation Ordinance No. 19 of 1974. This means that no person may harm, capture, possess, or transport this species, or keep it in captivity, without a permit from CapeNature, the provincial nature conservation authority. No commercial trade is allowed in this species, and any person conducting research on this species requires a permit from CapeNature" (WLT-CC, n.d.).</i>	Here, the reference illustrates a translated authority derived from the national legal structure and used to motivate and legitimate the work of the WLT-CC. It requires a form of governance knowledge to leverage conservation law in this manner.
Building governance knowledges and connecting into systems of governance	<i>"After the first years' experience, the Toad NUTS leader knew who to speak to at Telkom and Eskom went directly to these people, and this part of the process went relatively quickly. The leader was then told that there are fibre optic cables under the road. [data extract: There is no real guide. One has to go from pillar to post discovering the procedure to follow for yourself. After getting these approvals, the Roads and Storm Water Department officials are still evasive because they are not exactly sure who to approach about the fibre optics] (van Wyk, 2015:62).</i>	This extract evidences the development of governance knowledges over time, and the significance of such knowledges in enabling monitoring and applied conservation initiatives. It also demonstrates the barriers that the lack of governance knowledges caused within the project context.
Informing municipal management strategies	<i>"The City's environmental department has further signed service level agreements with other line functions responsible for the maintenance of public land within the Western Leopard Toad's distribution. These agreements changed the operational management of these spaces and watercourses to ensure the protection of the Western Leopard Toad during crucial periods of their life cycle, and are continuously reviewed in light of the changes in distribution informed by the GIS layer" (Measey, Dorse & Faraday, 2012:16).</i>	One of the ways in which monitoring data has been utilised has been to inform municipal maintenance processes and cycles, demonstrating the application of scientific knowledge towards municipal governance practices.

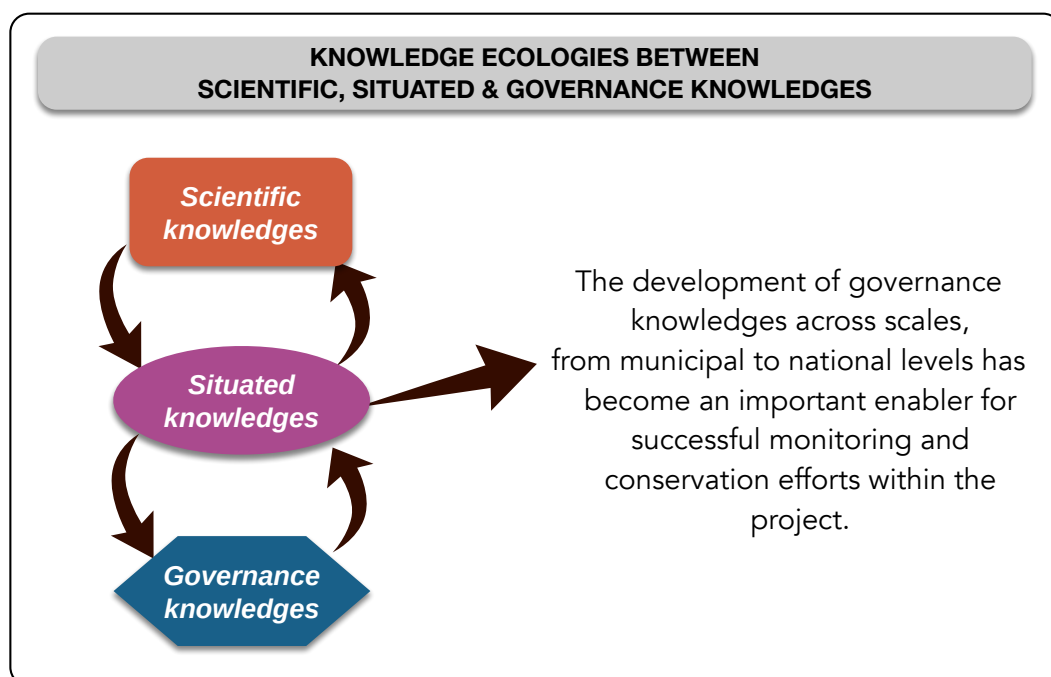


Figure 41: Developing governance knowledges to facilitate monitoring and applied conservation actions within context.

7.4.3.3. Evidencing other forms of knowledges

In addition to scientific, situated and governance knowledges, there is also evidence of a range of other knowledge forms within this epistemic culture. These knowledges seem to primarily be leveraged by citizen scientists, in support of localised priorities and risk-responsive strategies.

Table 19: Illustrative evidence of other knowledge forms

EVIDENCING OTHER KNOWLEDGE FORMS	Illustrative evidence	Analytical notes
Building relational knowledges	<i>"[data extract: We started stepping on toes without really understanding what was happening]. The lesson learnt was that it is really important to work with the existing structures or people in an area and then to be very diplomatic. [data extract: They have to work out how they manage their volunteer group for themselves. If they need a conservation initiative which is often the case, the local members have to design strategies that suit their circumstances, and implement this themselves]. It has been the experience of the Toad NUTS leaders that people work best and remain volunteers for longer, when patrolling in their own areas rather than working in neighbouring suburbs" (van Wyk, 2015:59).</i>	This extract illustrates the development and refinement of relational knowledges over time.
Leveraging a range of citizen knowledges and skills towards toad conservation	<i>"One of the Toad NUTS leaders is a Montessori school directress and she created a presentation teaching children about the Western Leopard Toad" ... "A member, who is a journalist, is dedicated to the task of writing articles. She says that she writes at least two articles per season, one before and one after, reporting on the findings of the season and inviting people to join the group. She has knowledge and experience of how to approach the various media authorities to have Toad NUTS material published" (van Wyk, 2015:56).</i>	A range of professional skills and related knowledges are mobilised by volunteers in the toad conservation efforts, as demonstrated by this extract of data.
A form of embodied knowledge	<i>"Through doing patrolling, Toad NUTS volunteers have developed a search image (an acute visual perception) for the toads which enables their patrolling success. This was learnt as they gained patrolling experience" (van Wyk, 2015:70).</i>	Local monitoring efforts engage a range of knowledges, including embodied knowledges, as illustrated here.
Leveraging relational knowledges and foregrounding relationships	<i>"We have a very good relationship with our ward councillor who helps us with a range of things" (Faraday, 2014).</i> <i>"Toad NUTS has attracted many members and after many years the group is still flourishing. The leaders feel that this is because they pay attention to the social relations of the group" (van Wyk, 2015:67).</i> <i>"Existing and new volunteer groups became empowered by pooling resources and sharing knowledge with conservation professionals" (Measey, Dorse & Faraday, 2012:15).</i>	These three extracts illustrate a range of ways in which relational knowledges are being leveraged towards toad conservation efforts. Such knowledges are used to facilitate a range of diverse outcomes, all of which contribute to the success or failure of local conservation efforts.
Building future-orientated applied situated, scientific and conservation knowledges	<i>"[I]n 2011 more than 1,000 school children learned about Lenny the Leopard Toad. They also discovered how to prevent toads drowning in their swimming pools; how to cultivate the kind of gardens that suit toads; what to do if they find a toad in the road and how to educate their parents about toads" (Measey, Dorse & Faraday, 2012:15).</i>	This extract illustrates one epistemic process for developing a range of knowledges towards the future safeguarding and conservation of the Leopard Toad.

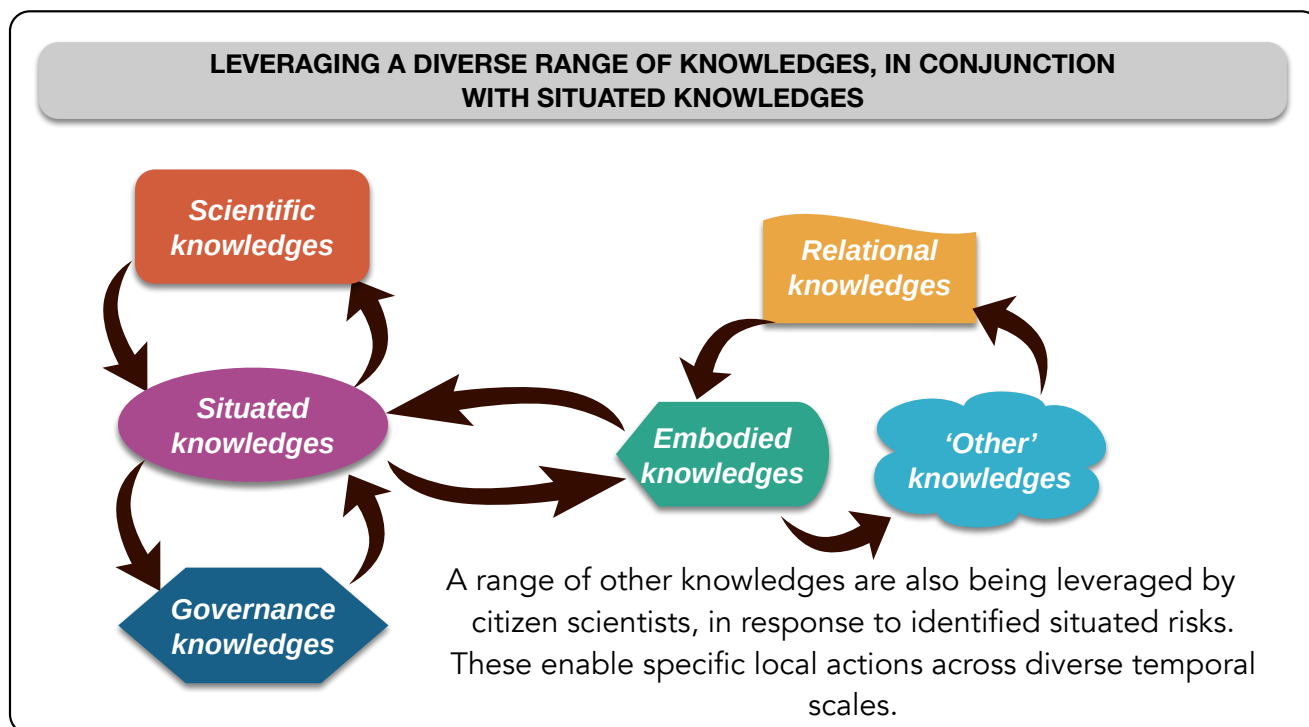


Figure 42: Leveraging diverse knowledges in conjunction with situated knowledges.

7.4.4. Translating Knowledges Into Applied, Risk-Responsive Strategies

Each of the knowledges evidenced above is mobilised in response to various scales of risk affecting the wellbeing of the Western Leopard Toad. The translation of knowledges into applied conservation and intervention strategies is evidenced across a range of data sources, at both formal and informal levels of reporting. Interestingly, knowledges are being mobilised across different timescales, with scientific knowledges enacted across the longest timescales, governance knowledges spanning short to long-term timescales, and situated knowledges being primarily mobilised within short-term timescales. Scientific and governance knowledges are enacted across particular, established pathways, while situated knowledges are translated into practice in more informal ways. In addition, scientific and situated knowledges are translated into interventions within governance systems within a range of ways.

Table 20: Illustrative evidence of the translation of scientific knowledges into applied, risk-responsive strategies

TRANSLATING TECHNO-SCIENTIFIC KNOWLEDGES INTO APPLIED CONSERVATION PRACTICES	Illustrative evidence	Analytical notes
Planning an iterative relationship between scientific research and applied conservation	"For the Western Leopard Toad a provisional research agenda has been designed up to aid with immediate conservation planning needs" (WLT-CC, n.d.).	Here, the intention to inform applied conservation through scientific research is articulated.

TRANSLATING TECHNO-SCIENTIFIC KNOWLEDGES INTO APPLIED CONSERVATION PRACTICES	Illustrative evidence	Analytical notes
Scientific findings informing applied practices	<i>"The Final Breeding Report 2008 shows that in the first year there were fewer toads seen and a greater road kill percentage. This indicated that more people and more patrols were needed but knowledge was gained during that year that could be passed on to others in the second year" (van Wyk, 2015:47).</i>	This extract illustrates the translation of scientific data derived from monitoring activities into applied conservation activities.
Translating knowledges into situated practices - scientific findings informing applied practices	<i>"Over the first six years of Toad NUTS activities, records show that approximately 20% of moving toads are lost through road kill despite patrolling. Toad NUTS concluded that "patrols are not enough and can be dangerous" therefore, road patrols should be reserved for work on quieter suburban roads, where traffic volumes are lower and where the risk to patrollers is less. This quote reveals that Toad NUTS reflected on their data and actions, concluded that their main activity, patrolling, is dangerous in places and not effective enough in achieving the goal of eliminating road kill" (van Wyk, 2015:48).</i>	Here, the extract illustrates an integration of scientific and situated knowledges being leveraged to inform future monitoring and conservation strategies.
Translating knowledge into situated practices - Techno-Scientific innovations adapted to local contexts to inform applied practices	<i>"Unfortunately it [a barrier system designed by a volunteer-engineer] was a very expensive system which the group did not have the funds for. Instead they adapted the idea to a simple and relatively inexpensive temporary barrier and bucket system which they could install at a fraction of the cost. They identified where the most suitable place for this installation would be from previous experience substantiated by analysis of previous records" (van Wyk, 2015:48-49).</i>	The translation of techno-scientific innovations which are adapted into local priorities and resource availability is illustrated here.
Translating scientific knowledges into situated practices	<i>"Toad NUTS produced a DIY guide and pamphlet showing home-owners their proximity to the known breeding ponds, and how to 'toad-proof' their gardens and swimming pools" (van Wyk, 2015:50).</i>	Here, we see the translation of monitoring data into situated knowledges and associated practices. Data is translated into locally 'useable' knowledge resources.
Reading scientific data in conjunction with situated experiences	<i>"Toad NUTS members do feel that keeping records is important and has been key to detecting various important things like toad behaviour patterns and where the important toad breeding areas are. With data the success of patrolling can be measured. If data was not recorded, much information may have been missed. For example, it was found that one year a particular stretch of road could be busy and the next year it is quiet" (van Wyk, 2015:64).</i>	Where scientific knowledge tends to account for broader patterns of movement, the integration of situated knowledges enables more focused and contextually relevant translation of data into applied conservation and monitoring practices.
Reflecting on scientific data to inform ongoing planning and monitoring in local contexts	<i>"The analysis of the data generated is important for interpreting how the toad responds to changing weather in different years. The review of the data also allows for a review of practices and the consideration of amendments to practices as well as the deliberation of other strategies" (van Wyk, 2015:71).</i>	Here, the extract points to an iterative relationship between monitoring to generate scientific data, and using scientific data to inform monitoring activities and local epistemic and conservation practices.
Informing development systems and Environmental Management Plans	<i>"In collaboration with the WLT-CC, a Construction Phase Environmental Management Plan and Checklist, as well as a Development Design Checklist was compiled and incorporated into development applications within the distribution range of the Western Leopard Toad" (Measey, Dorse & Faraday, 2012:16).</i>	Here, the extract evidences the translation of scientific knowledge into Environmental Management Plans

TRANSLATING TECHNO-SCIENTIFIC KNOWLEDGES INTO APPLIED CONSERVATION PRACTICES	Illustrative evidence	Analytical notes
Translating knowledges into situated practices, and towards mobilising monitoring resources	<i>"Volunteers also collect indispensable information on breeding times, numbers of toads and breeding sites. This is done while rescuing toads ... These data are used to determine conservation plans for the following year, to obtain funds, and to update the conservation status of the species" (WLT-CC, n.d.).</i>	This extract illustrates the diverse ways in which scientific knowledges are mobilised within the project.
Leveraging scientific knowledges to inform development practices	<i>"It is important to provide developers with comprehensive information regarding threatened species - not only on the particular site but in fact all threatened species within a city's boundaries" (Young, 2010:21).</i>	One application of scientific knowledges is their translation into development plans in the form of Environmental Impact Assessments.

Table 21: Illustrative evidence of the translation of situated knowledges into applied, risk-responsive strategies

TRANSLATING SITUATED KNOWLEDGES INTO APPLIED CONSERVATION PRACTICES	Illustrative evidence	Analytical notes
Applied situated knowledges	<i>"The WhatsApp communication mechanism facilitates the social connections between Toad NUTS members and is used as a quick feedback system to accommodate changes, adjustments, report back and questions. Essentially the WhatsApp system has created a network connection system that everyone taps into and gleans information from. A benefit of the system has been that members can share difficulties which they encounter while patrolling in real time and get a response from others very quickly. Scientists and other experts are also members of the WhatsApp group and can give expert opinion when needed" ... "This means that members can tap into collective deliberation processes and benefit from the collective group wisdom while in the field at the time that a tricky decision must be made" (van Wyk, 2015:52-53).</i>	This extract shows the importance of communication systems and networks in the development and also mobilisation of situated knowledges.
Translating situated experiences into a commons of situated knowledges	<i>"The Toad NUTS group have learnt many things through experience over the nine years of its existence that have been meaningful to them. They have refined their patrolling practices which have resulted in a reduction of road kill numbers. The success of different conservation strategies particularly the barrier system along certain stretches of road has reduced road kill to 0%. The education and awareness initiatives that they present are meaningful as they have reaped the benefit of greater sensitivity to the plight of the toads and a greater understanding and support in the Noordhoek community of the Toad NUTS practices and initiatives. Experience has meant learning new things about the toads in the local environment which has given Toad NUTS members a voice in the community and in the conservation field and enabled members to participate in management or government processes" (van Wyk, 2015:75-76).</i>	This extract points to the development of a commons of situated knowledges over time. Evident is the significance of this commons in informing applied actions and responses to situated risks, and the translation of situated knowledges into larger systems of toad conservation.

TRANSLATING SITUATED KNOWLEDGES INTO APPLIED CONSERVATION PRACTICES	Illustrative evidence	Analytical notes
Adaptive practices in responses to situated knowledges	<i>"When designing the bucket and barrier system, the following quote illustrates how volunteers altered the buckets because they knew that rain is a factor when the toads move: [data extract: So what we did with these buckets was just to make sure there's drainage, so there's holes in the bucket]. This is something that was learnt and had to be taken into account while working the barrier. The buckets have drainage holes and lids. When the water table rises and the buckets fill, the bucket is closed with the lid and the toads cannot get in. This prevents drowning. Toad NUTS know that toads can only float for about a day before drowning" (van Wyk, 2015:73).</i>	Here, the extract demonstrates a set of adaptive practices informed by situated knowledges. The drainage holes were inserted when toaders realised that too much water in the buckets resulted in toads drowning. A second application of situated knowledges occurred when they realised that holes in the buckets were insufficient during heavy rains when the water table rose. Therefore, they adapted their strategy once again, closing the buckets entirely during such periods. [* Extract revisited with van Wyk during analysis]
Translating knowledges into situated practices - Applied conservation innovations emerging from situated knowledge production and intervention	<i>"Another example of a conservation initiative introduced by Toad NUTS is the 'toad saver'. After observing toads drowning in swimming pools, Toad NUTS devised a simple solution and encourage residents to install a device to the side of their pools. Essentially the toad saver consists of a square of rubber mesh fixed to the side of the pool with marine glue. The toad saver allows the toads to safely climb out of a swimming pool" (van Wyk, 2015:50).</i>	Here, what is illustrated is the development of a situated innovation which was informed by situated monitoring data.
Translation of situated knowledges into municipal management practices and timetables	<i>"With the Western Leopard Toad the City of Cape Town has a Memorandum of Agreement with the Western Leopard Toad Conservation Committee to cease mowing activities when toads emerge from ponds. Predicting emergence times is currently difficult, but with enough data and monitoring by citizen scientists, this task can become relatively easy at a large number of sites" (Tolley et al. in Measey, 2011:39).</i>	This extract describes the translation of situated knowledges into land use management strategies and Environmental Management Plans.
Innovating in context as a way of translating governance requirements	<i>"The Toad NUTS members realised that they could use estate agent boards upon the suggestion of another member of the WLT-CC, to put up the posters which works very well. Using this 'loophole' was a clever way to overcome the difficulty of applying the regulations in the local circumstances" (van Wyk, 2015:61).</i>	Demonstrated here is a situated innovation that allows citizen scientists to meet 'the letter' of municipal bylaws, while meeting 'the spirit' of local toad conservation priorities.
Translation of situated knowledges into land management practices	<i>"Mapping of the known breeding sites and the detailed distribution range of the Western Leopard Toad is carried out on an annual basis by WLT-CC members and forms the basis for informing land use management and development applications assessed by the City's environmental department" (Measey, Dorse & Faraday, 2012:16).</i>	This extract describes the translation of situated knowledges into land use management strategies and Environmental Management Plans.

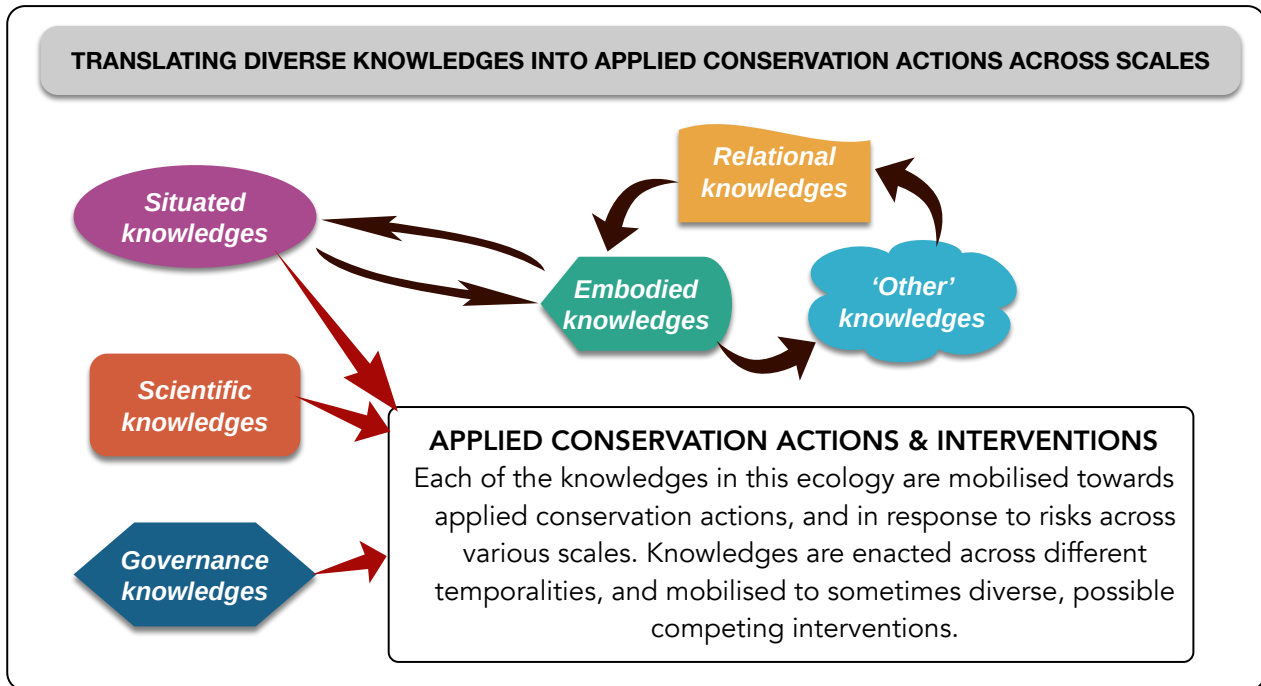


Figure 43: Translating diverse knowledges into applied conservation actions across scales

7.4.5. Competing Priorities and Senses of Urgency

Although the diverse epistemic subjects or knowers within this epistemic culture have a long history of interaction and collaboration, there is also evidence of competing priorities and senses of urgency amongst knowers. This is especially distinct between professional scientists, municipal officers, and citizen scientists. Issues of epistemic and distributive justice are foregrounded within these conflicting priorities, and the ways in which epistemic statuses are leveraged between professionals and volunteers is particularly evident.

Table 22: Illustrative evidence of competing priorities between epistemic subjects

COMPETING PRIORITIES	Illustrative evidence	Analytical notes
Tensions between municipal management processes and situated priorities and situated risks	"[data extract: The committee will have a meeting by the middle of July to talk through all the plans. By that meeting we need to have all the stickers for the posters. They have to be up from the 15 th July. We get given two months. That's really difficult for us because that could be a week too early and by the 15 th Sept, those toads could still be walking. When the posters come down then we feel very vulnerable because they could still be moving. The season is determined by the weather so I cannot say]. The use and installation of road signs is regulated by various bylaws that affect the actions of the Toad NUTS members. Putting up road signage for instance, is a simple enough physical task but in reality many bureaucratic processes must be negotiated before permission is granted to do so" (van Wyk, 2015:61).	This extract highlights the differing (and sometimes conflicting) needs and priorities between governance institutions and local citizen science volunteers. Especially evident is the sometimes divergent priorities between different State mandates - in this case, between safe-guarding biodiversity, and regulating public activities within national commons such as roads.

COMPETING PRIORITIES	Illustrative evidence	Analytical notes
Tensions between municipal management processes and situated priorities and situated risks	<i>"Permanent toad awareness signs, similar to road signs, were installed by the City of Cape Town in Noordhoek which Toad NUTS are not very satisfied with. Their concern is the false impression that these signs create that toads are always on the move because the signs are always there. Toad NUTS feel that the signs lose the desired effect because residents are so used to them being there. They were told not to pursue the issue with the City of Cape Town's works department, as there is a risk of losing the signs permanently. This department cannot manage the temporary installation of road signs. These incongruences impact the practices of Toad NUTS who hitherto have been unable to resolve the predicament"</i> (van Wyk, 2015:61-62).	This extract highlights the differing (and sometimes conflicting) needs and priorities between governance institutions and local citizen science volunteers. Especially evident is the sometimes divergent priorities between different State mandates - in this case, between safe-guarding biodiversity, and regulating public activities within national commons such as roads. It also highlights the effect of limited governance capacity on effective and timeous local conservation efforts.
Managing data collection on the ground - competing priorities between scientific data collection and toad protection	<i>"During the early years (2008-2009), toads were picked up, sexed, measured, photographed and their location was determined using Cybertracker [a citizen science system which included a hand-held monitoring device]. Now priority is given to moving toads off the road as quickly as possible. Photographing and locating the toads have been abandoned as it took too long to do and seems purposeless as no feedback was given to the volunteers"</i> (van Wyk, 2015:48).	Here, there is evidence of a conflict in priorities, between localised and immediate toad rescue strategies, and the longer-term building of scientific knowledges. Each priority is enacted through a different temporality.
Competing governance priorities	<i>"The use of culverts and similar conservation interventions are mentioned in the draft biodiversity management plan for the Western Leopard Toad (Rebelo et. al, 2013). This document should prepare the way for the realisation of these types of measures. Even though authorities like SANBI and the Department of Environmental Affairs support this idea, the situation can be complicated because the problem will demand working across local government service departments"</i> (van Wyk, 2015:63).	This extract demonstrates an intended governance structure and pathway to enabling toad conservation, as well as competing priorities between governance structures between scales. There are two forms of governance knowledge required to navigate the relations between governance institutions.
Tensions between municipal management processes and situated priorities and situated risks	<i>"When a Toad NUTS leader was asked about the process involved in installing the 2013 barrier, she answered that it took months to get the necessary permissions and that it involved an extended period of navigating bureaucratic processes. [data extract: I had to go through the environmental people and they took about 6 weeks to get back to me and then they let me know that because I am digging into the ground for the buckets, I will have to get permission from Telkom and Eskom [parastatal telecom and energy utilities]. Then I had to meet Telkom and Eskom at the side of the road and they said "Oh please there are no cables there". It's 30 cm deep, there are no cables there. They [the City of Cape Town] then wanted to charge us a R2500 deposit and finally they agreed that we needed to pay R450 to put in the barrier]. In 2014 it took an equally long time that is, four months, to obtain the necessary permissions to install the barrier"</i> (van Wyk, 2015:62).	This extract highlights the differing (and sometimes conflicting) needs and priorities between governance institutions and local citizen science volunteers. Especially evident is the sometimes divergent priorities between different State mandates - in this case, between safe-guarding biodiversity, and regulating public activities within national commons such as roads. It also highlights the effect of limited governance capacity on effective and timeous local conservation efforts.
Epistemic roles and statuses	<i>"Aims</i> <i>To build capacity in professionals practicing conservation and taxonomy of amphibians in South Africa.</i> <i>To promote awareness and appreciation among the general public as to the inherent value of biodiversity, of which amphibians are an integral part"</i> (Tolley et al. in Measey, 2011:37).	Here, the extract, written by professional scientists employed within biodiversity governance agencies, demonstrates clear differentiation between the epistemic roles and statuses of professional vs civic members of the same society.

COMPETING PRIORITIES	Illustrative evidence	Analytical notes
Conflicts over volunteer time and energy	<i>"One of the things that they wanted us to collect is photographs of toads, and we did for a long time, but it sort of became clear that no-one was doing anything with those photographs - they were going nowhere" (Faraday, 2014).</i>	Again, this extract demonstrates issues of cognitive and distributive justice. Citizen scientists are being asked to perform epistemic tasks and contribute personal resources, without appropriate reciprocity or valuing of such contributions.
Conflicting priorities between building scientific knowledges and mitigating situated risks	<i>"A contentious issue has been the generating of data by volunteers and has led to friction between the scientists in the WLT-CC and the volunteers. [data extract: [The SANBI scientist] did prescribe what he wanted and during the first couple of years he got what he wanted except for a couple of things which were impractical like taking a photograph and uploading on iSpot. You know you are working under huge pressure on the road. There are cars and you just want to get the toads off the road. Sometimes people take photos of the toad when the road is quiet but most times you are under huge pressure and don't have time for photographs. We did use Cybertracker and [the other leader] got some cyber trackers donated. But for me if anything is going to take more than thirty seconds, I'm not going to do it and neither will I recommend my volunteers do it, because it is dangerous. We are doing extreme conservation here and there are more animals being killed further down the road so you have to hurry]. What is sensible and sage to do in the local conditions when working on busy roads in dark and usually rainy conditions, is the volunteers' first consideration" ... "[data extract: We have had this standoff on the committee where we have felt that they don't really get what we are doing. We are there to save toads ... and to keep the species from becoming extinct. They feel that we don't get what it means to do proper science ... and we don't really care about that as much as they feel we should but I think that the data that we keep is amazing for what we do] (van Wyk, 2015:63).</i>	In this extract, situated knowledge and application of that knowledge superseded the need to build scientific knowledge. The extract also demonstrates issues related to epistemic justice and participatory democracy. Here there is a tension with the State institutions expecting citizen volunteers to enact State organisational mandates, rather than enacting civic aspects of participatory democracy.
Privileging scientific forms of knowledges above other knowledges	<i>"Conservation decisions for the Western Leopard Toad, like other animals and plants, need to be based on precise data obtained from objective research" (WLT-CC, n.d.).</i>	This extract evidences a bias towards scientific knowledges and governance systems informed by scientific knowledges.
Conflicting priorities between building scientific knowledges and mitigating situated risks	<i>"Volunteers have become wary and suspicious of the scientists due to the friction and poor communication. [data extract: Volunteers are just not interested in added administrative tasks at the end. For example, we were requested to upload our photos to iSpot, the SANBI biodiversity mapping and identification website. I get that if I want different frogs identified that's good, but why would I upload 1800 records for the Western Leopard Toad? What is the point then? The scientist was very scathing about us not using iSpot. The other thing is that it is a lot of work ... iSpot is a step too far and it does turn people away. It's too much and it does nothing for us. The data recorded must be purposeful and doable by the volunteers while patrolling]. Volunteers can feel abused when unreasonable demands are made of them and no feedback is given concerning how the data which is generated, is being used" (van Wyk, 2015:64).</i>	In this extract, situated knowledge and application of that knowledge superseded the need to build scientific knowledge. The extract also demonstrates issues related to epistemic justice and participatory democracy. Here there is a tension with the State institutions expecting citizen volunteers to enact State organisational mandates, rather than enacting civic aspects of participatory democracy. It also highlights the differentiation of epistemic roles, with volunteers as "hands" instead of "heads" (after Faraday).

COMPETING PRIORITIES	Illustrative evidence	Analytical notes
Issues of epistemic legitimacy	Interviewer question: "How would you rate the validity of the data generated by your volunteers?" Faraday response: "It's very interesting, that - because that is what they use to discredit us slightly, I feel. And with [a researcher] coming around, he was saying SANBI and people like that - they want ... unless something is done by a doctoral student or a scientist or something, it is meaningless ... for example, when I wanted to put up the barrier [SANBI scientist] was like 'you can't prove whether it's a success or not because you didn't have a patch of road with a barrier, and a patch of road without a barrier' ... I mean it's the most ludicrous thing because in actual fact that is what did happen because we couldn't get the barrier up in time ...so we did have a part of a barrier up for one night because we hadn't completed it ... so we did have deaths on the section that wasn't barriered, but apparently that wasn't scientific enough ... and we've had years of toads dying on that stretch but apparently that isn't science" (Faraday, 2014).	This extract demonstrates epistemic justice issues, and the application of scientific forms of rigour onto situated practices. Scientific forms of rigour are used to delegitimise situated knowledges informing situated practices.
Issues of epistemic legitimacy and problematic allocation of epistemic statuses	"They [the Endangered Wildlife Trust] are very good at bridging that gap between the citizens and the science ... in no way have they been sort of 'dissing' [slang for dismissing] of the work that we do, because we do sit on a committee with SANBI and SANParks and Cape Nature and City [City of Cape Town], and generally it's a difficult relationship because they don't really think that the work we are doing is ... I don't know ... it's hard to describe ... but it does often feel like where they regard us as the hands and they're the head - we also feel we have heads" (Faraday, 2014).	This extract demonstrates issues of epistemic status resulting in epistemic justice issues between professional scientists and government officials, and citizen science volunteers.
Epistemic roles and statuses	"The general public can also contribute to specific projects through citizen science. Simple citizen science projects can provide important data for amphibian conservation ... More importantly, their contribution will afford them a greater understanding and appreciation of the environment" (Tolley et al. in Measey, 2011:37).	Issues of epistemic justice are highlighted through clear divisions in epistemic status and legitimacy between professionals and citizen scientists. Citizen scientists are constructed as engaging in 'simple' epistemic tasks which are primarily beneficial for developing scientific literacy, rather than making robust contributions to toad conservation or generating useful knowledges.

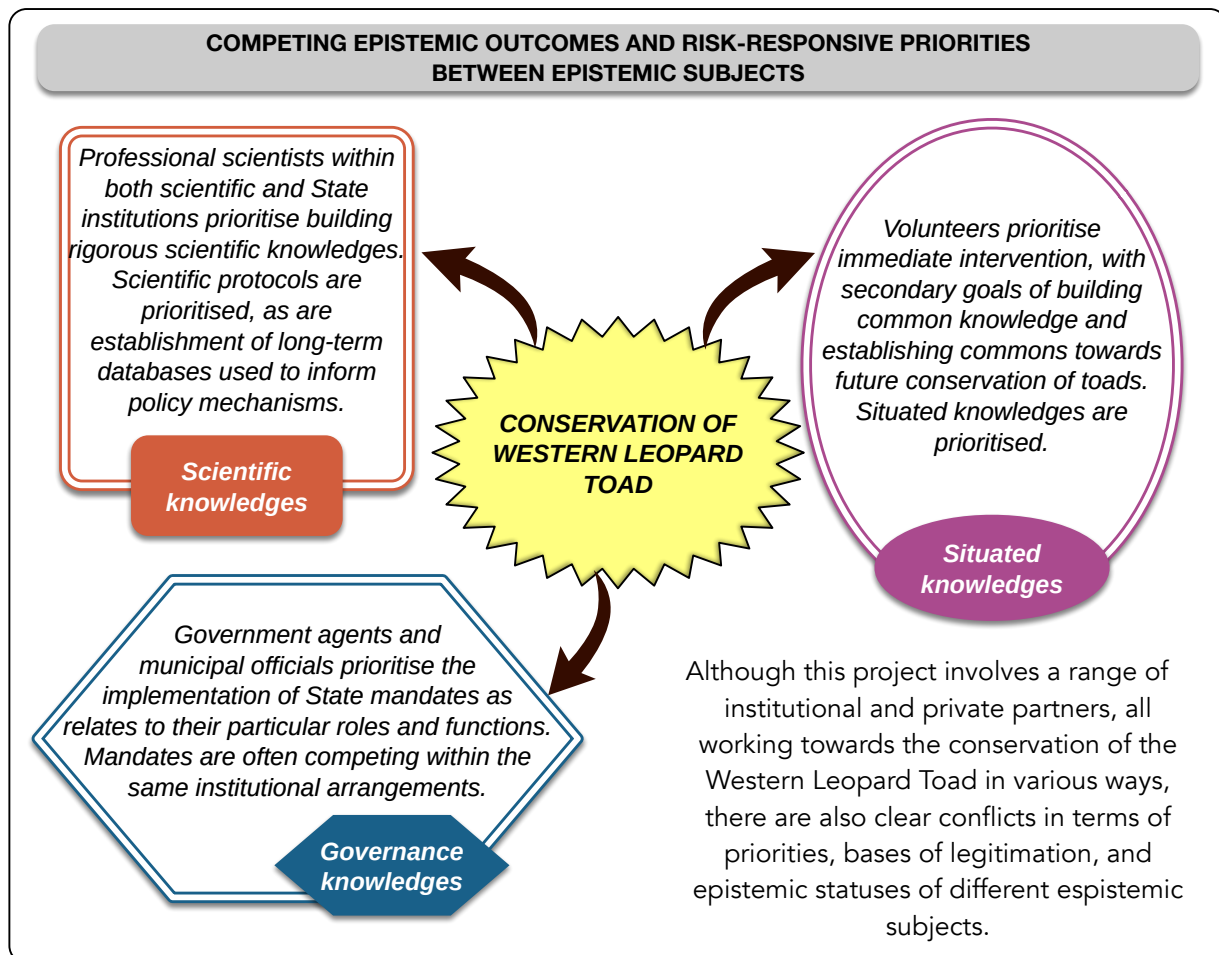


Figure 44: Competing priorities and ways of mobilising knowledges in response to social-ecological risks threatening the Western Leopard Toad

7.4.6. General Comments

This case study, once again, illustrates a rich and complex epistemic culture. As evidenced in the extracts, the building of diverse types of common knowledge is reliant on the mobilisation of integrated ecology of knowledges. The development of scientific knowledges would not be possible without the rich insights and responsiveness of situated knowledges, and situated knowledges rely on scientific processes of legitimation to measure efficacy and impact over the long-term. Both are required to inform and access systems of governance across various scales. Also evident is the challenging nature of knower and knowledge interactions where there is an unequal basis of legitimation informing epistemic statuses. In this case study, the power of situated knowledges to inform immediate conservation actions is highlighted, even as such forms of knowledge are clearly devalued within the wider system of formalised conservation actions related to the toad. The epistemic contributions of citizen scientists have been framed in quite specific and hierarchically denigrated ways by professionals within the project, as have the knowledges they produce.

Also evident is that the production of scientific knowledges by citizen scientists, which is foregrounded and prioritised by professionals within the project, remains largely unused beyond the citizen scientists themselves. This tendency calls into question the imperative for the production of scientific knowledges in this instance, and whether scientific knowledges are indeed the most useful form of knowledge for this form of situated social-ecological risk.

7.4.7. Mobilisation of Knowledges in Response to Social-Ecological Risk

Three primary forms of knowledges are being mobilised within this project, including:

- Scientific knowledges, in form of species data and mapping, as well as monitoring statistics within and across breeding seasons;
- Situated knowledges, in the form of local conditions, threats, and systems of risk and impact. This form of data appears to play a key role in immediate interventions within local contexts, and be highly mobilised by citizen scientists;
- Governance knowledges, in the form of knowledges of how to generate useable data to inform national policy, as well as functional knowledges used to interact with local regulatory functions at municipal and parastatal levels of governance. Governance knowledges appear to be enablers for translating scientific and situated knowledges into applied conservation actions and local interventions.
- Additionally, there are a range of other knowledges, mobilised in conjunction with situated knowledges, which support and enable monitoring, applied conservation and local interventions. These include relational, embodied and what might be described as professional knowledges.

As with the previous projects, the ecology of knowledges within ToadNUTS seems to enable a highly flexible and responsive epistemic culture which is able to be mobilised across scales towards various epistemic and risk-responsive outcomes. Different knowers access diverse epistemic outcomes, and mobilises them towards diverse goals. Citizen scientists mobilise primarily situated, but also scientific and governance knowledges to inform and facilitate toad rescue and mortality-reduction interventions within their local environments. Professional scientists mobilises scientific knowledges and governance knowledges in order to build and refine scientific cannons, as well as to inform institutionalised biodiversity governance structures. Government agents and officers mobilise situated and scientific knowledges to inform both

policy construction, as well as resource management functions. The interactions between these forms of knowledge applications are seemingly not always coherent, nor aligned, with competing priorities and limited resources informing which actions are implemented, and towards the fulfilment of which mandates and functions.

7.4.8. Enacting State Mandates versus Participatory or Radical Democracy

As with the other case studies in this chapter, the data extracts evidence contradictory relationships between enacting and fulfilling State mandates, and participatory or radical contributions to democracy. Within this case study, the transference of State responsibility is primarily enacted through the directive to collect scientific data - a directive which arises from professionals (who are projecting their institutional mandates) who seek to distribute the various mandates amongst citizen scientists. The problematic of this dynamic is further evident through the uses and non-uses to which scientific data generated by citizen scientists, is being put. The evidence of tensions between differing priorities articulated by citizen scientist and different groups of professionals further highlight this blurring of epistemic and social boundaries.

The citizen scientists in the project have highlighted their priority for saving toads from being killed within the local environments in the short-term. While they have demonstrated a willingness to support the generation of scientific data, the epistemic relationships between them and various groups of professionals within the project remain unequal, with institutional mandates within various State organisations dominating how official resources are mobilised and aligned to institutional priorities. This arrangement is, in itself, not concerning because State institutional resources that have been set aside to fulfil particular mandates are obligated to them, and the State officials - be they scientist or municipal officer - are legally required to fulfil those mandates in accordance with their service agreements. Rather, the concern arises when such mandates are divested onto the citizenship, and resources mobilised by such citizens are appropriated into State functions, and the priorities and imperatives of citizens engaging in participatory and radical acts of democracy are redirected towards the fulfilment of such mandates, even as their systems of contribution are delegitimated on grounds of misalignment with State mandate.

Instead, we might ask how the various State functions related to biodiversity conservation and municipal maintenance might form alliances with citizen scientists, so that the State retains responsibility for mobilising and fulfilling State mandates, and citizens are invited into participatory relationships which might enhance and support the fulfilment of such mandates, or radical relationships which might challenge and call the State and enactment of State functions to account. Such relationship would need to recognise the regulatory role of the State, across its functions, while also enabling the enactment of robust forms of participatory and radical democracies.

In the case of the Western Leopard Toad, this would require a pragmatic review of the ways in which citizen scientists are threatening the long-term wellbeing of toads, or unproductively challenging State functions, and simultaneously reviewing and revising dysfunctional, inadequate, or misaligned State functions, so that they form a coherent system of joint custodianship with citizens in regards to Western Leopard Toads. As Edwards (2011) proposes, the clear delineation of roles and functions between various epistemic subjects within this commoning community would also enable more coherent collaboration. The delineation of roles and functions should be geared towards transparency, and not as a way to entrench hegemonic processes of knowledge production and hierarchies; along with *collaborative* role clarification, issues of epistemic, contributory and distributive also need to be negotiated and made transparent. These processes of negotiation are themselves, processes of commoning.

7.4.9. Produced Nonexistence versus Epistemic and Distributive Justices

This case study provides clear illustrations of produced nonexistence, and highlights issues of epistemic and distributive justices (see 1.3). Citizen scientists are hierarchically positioned within power structures, and categorised into epistemic positions which are enacted through limited epistemic roles and functions in ways which do not reflect the enacted reality of the project. For example, citizen scientists are positioned both within the ‘coordinating committee’, and within official State dialogues (and here I include official scientific dialogues because they are one and the same within this project context) about amphibian conservation strategies as subordinate to the professional tasks of State scientists and policy developers, or municipal management roles. In Measey (2011), for instance, citizen science contributions are described under “education, awareness and capacity building”, rather than other categories of contribution in the report,

which included “building a strategy for amphibian conservation”, “understanding and documenting species diversity”, “conservation and ecological studies”, and “assessing status and trends”, which the data extracts above suggest might equally validly be applied to the contributions of citizen scientists.

A further example of such epistemic positioning can be seen in the description of threats to the Western Leopard Toad in the same report, in which Measey notes that,

Research is needed to determine population trends and the importance of perceived threats. A Biodiversity Management Plan (under NEMBA) is required to underpin Memoranda of Understanding between multiple stakeholders. Monitoring is required at known breeding sites to determine their efficacy, especially in the eastern range. There is great potential to significantly improve the status of this species through conservation planning and control of threats posed by alien species ... It occurs on the [list of provincial conservation areas]. However, much of its remaining habitat is made up of urban gardens, is unprotected, and requires significant public education to make any conservation measure a success (Measey, 2011:52).

Here again, we see the positioning of citizen scientists within very specific, subjugated epistemic roles to those of professional scientists, when in reality, citizen scientists within this project have already made significant contributions to wider biodiversity policy, conservation plans, monitoring databases, convening multiple stakeholders, and safeguarding the conservation status of the toads. Nor have their contributions been limited to urban gardens. In addition, citizen scientists have supported the re-alignment of municipal functions so that they are more directly responsive to toad conservation, as well as challenging various State directives as they themselves generate situated risks to toads. Issues of both cognitive and distributive justice are implicated here - both in the allocation and appropriation of resources towards the fulfilment of State functions, and towards the fulfilment of research processes which primarily and most directly benefit professional scientists, as well as through the denigration of the knowledges produced by citizen scientists - be they scientific or otherwise.

7.4.10. ToadNUTS Case Conclusion

The ToadNUTS case study demonstrates yet another example of how the epistemic culture of a citizen science project might be convened and articulated. This case study evidences yet another way in which citizen scientists and State officials have collaborated and responded more directly and specifically to a situated social-ecological risk. The configuration of this epistemic culture has enabled a range of responses to diverse risks impacting the wellbeing of the toad in question, across geographical, governance and temporal scales. The contributions of knowledges beyond scientific knowledges is made evident, as are processes of producing them

as nonexistent. Of particular interest is the illustration of how diverse parties with a shared goal (conserving the Western Leopard Toad), enact that goal differently, and sometimes in opposition with each other. Related to this are the ways in which epistemic roles, statuses, and authorities are leveraged, legitimated and mobilised to foreground some enactments while backgrounding or subjugating others. While challenging in some ways, this system of commoning might still claim a range of substantive successes, as evidenced by the continued existence and conservation status of the Western Leopard Toad.

7.5. Chapter Discussion

On the one hand knowledges are the product of human movement, actions, practices and protocols. It takes active work to transform the world into knowledges and they are embodied in people, their activities, relationships and in their tools, artefacts and all forms of technology - especially modes of representation, communication, and mensuration. On the other hand knowledges are not abstract entities, they are the conjoint practices of groups of people, and shape the world they inhabit. In practicing and making their knowledges of the world, people make themselves, the societies and the spaces they inhabit. In moving and acting they perform their knowledge spaces, they create trails, they 'know as they go' through the cognitive and physical landscape (Turnbull, 2009:3).

As Law (2004), Latour (2004), Cetina (2007), Turnbull (2009, 2007), Haraway (2015, 1985) and others have demonstrated and argued, knowledges are not simply cognitively generated - rather, they are the products of human movements, interactions, relations and inter-relations, practices, protocols, theories, and ways of being and moving through the world. Responding to social-ecological risks, transforming the world, (re)stor(y)ing the world, recreating the world, and translating these movements into knowledges takes active work. Knowledges are embodied within human bodies and biophysical environments, policies and institutional structures, through geo-political maps, knowledge artefacts and cultural representations, technologies and medias, networks and relationships, and simultaneously arise from all of these as an articulation of such movements.

Within the epistemic cultures of the three citizen science projects evidenced above, these movements and co-constructions of knowledges are made visible as the conjoined, inter-related, and both interdependent and dependent practices that they are. We also begin to see that knowers themselves leverage a range of knowledges within their epistemic interactions, actions and reactions. Commoning, within these projects, seems to occur most successfully, where such epistemic interactions are enabled, giving rise to socially attenuated and calibrated artefacts, tools, protocols and practices.

These case studies also demonstrate the efficacy of Latour (2004) and Santos's (2004) arguments about foregrounding the ability to intervene into context as a primacy measure of rigour when engaging ecologies of knowledges, and articulating 'matters of concern'. These case studies demonstrate the ways in which the need to respond to social-ecological risks supersede and expand more established processes of scientifically produced and institutionalised knowledge into a much needed wider ecology of knowledges. The increased potential for risk-responsiveness that these arrangements afford are implicated in the complexity of knowledge production processes and epistemic diversity. In the three cases studies, there is evidence that such ecologies of knowledges are better able to support more short-term actions and reactions to such situated risks, while simultaneously contributing to the construction of knowledges commons that might be leveraged towards informing longer-term risk reduction or mitigation strategies.

Also evident is the unique configuration of each epistemic culture - once again, we see demonstrated the plurality of citizen sciences - each drawing on relations between professionals and citizen scientists, and diverse ecologies of knowledges so that their comparisons with each other are at a general level, rather than within the specific epistemic processes and practices being employed.

7.5.1. Mobilisation of Knowledges in Response to Social-Ecological Risk

The three case studies were selected because they illustrate how similar forms of knowledge can be engaged to inform and resource vastly diverse types of interventions in the world. They reflect the arguments of Santos (2004) and Latour (2004), regarding context-relevance as a basis for legitimisation within an ecology of knowledges - in other words, whether a particular form of knowledge is legitimate within a particular context, based on it's ability to enable intervention into that particular context. For example, governance knowledges form part of each of the ecologies of knowledges in the three case studies above - however, the form, function and role of governance knowledge within each project varies significantly.

- a) In the *CREW* project, governance knowledge informs the design of the project as a whole, and delineates the types of activities and focus of the common knowledge being built - here, the role of governance knowledge is to shape epistemic activities so as to inform and

enable governance structures and support the fulfilment of governance mandates. Governance knowledge is mobilised to both inform knowledge production, and to support translation of such knowledge into applied management of biodiversity resources. The relationships to local and provincial systems of governance are often authoritative and directive;

- b) In the *Khulumani Water for Dignity* project, governance knowledge is mobilised in order to challenge dysfunctional governance structures in ways that are perceivable by state systems (like municipal mandates and management structures), and in order to 'arm' citizens to advocate for rights against the spokespersons for such structures. The relationship to local governance structures is, in some ways, antagonistic and challenging, while simultaneously seeking to re-establish better aligned systems between State and citizens;
- c) Finally, in the *ToadNUTS* project, governance knowledge is engaged in multiple ways by various parties (some of whom are government officials) across various governance systems; here the focus of governance knowledge is related to public participation in biodiversity management at very practical, situated levels, as well as informing larger systems of governance at macro scales. Informing municipal timetables and vegetation management systems are of interest - both for concerned citizens who are working to create enabling conditions for toad conservation, and for municipal and provincial government agencies who draw on such volunteer groups to inform and also implement parts of their governance mandates. The relationship to local government structures is intended to be cooperative and collaborative; expanding to more contributory modes at broader governance levels.

Similarly, there is an observable difference in how situated knowledges, scientific knowledges, and other knowledge forms are mobilised across each of the three case studies. What has become apparent is that how knowledge is built and then mobilised depends not only on the *inclusion* of particular forms of knowledges, but also on *how and why* specific knowledges are included within an ecology of knowledges. *Sequences* of knowledge integration, as well as *motivations* for doing so are significant, and generate epistemic outcomes correspondingly.

7.5.2. Intersecting Enactment of State Mandates with Active Citizenship

Another trend visible across the three cases is the potentially contentious relationships which arise between State institutions and citizen science groups. As demonstrated, there is the

potential for fruitful knowledge co-production which might be easily translated into situated risk-responsive actions while simultaneously supporting coherent fulfilment of State mandates. Also visible is the tendency for institutionalised systems (whether under the guise of scientific or State), to appropriate the motivations and resources of citizen scientists towards the fulfilment of their own goals and obligations. Such appropriations are not necessarily intentional, but may rather be a function of the path-dependencies that institutional arrangements (especially those with dominantly hegemonic epistemic cultures) perpetuate. From the cases analysed, two key dangers become visible:

- a) The steady divestment of State responsibilities onto citizens (including scientific institutions which form part of the State infrastructure at epistemic levels). This includes epistemic, management and resourcing responsibilities;
- b) The erosion of participatory and radical forms of active citizenship which contribute to and enable functional democracies. These are in danger of being replaced by systems which require citizen compliance and contribution only along pathways which reinforce existing State and scientific structures.

Both dangers serve to perpetuate epistemic and distributive injustices, as well as eroding the potential for coherent and freedom-enhancing forms of contributive justice as regards the management, co-management, and re-articulation of systems of commoning required to establish and maintain commons of integrity.

This raises important questions about how we might build mutually enhancing systems of State governance and participatory or radical forms of active citizenship which enable coherent forms of commoning towards the common good?

Here, the work of Edwards (2011) and Benhabib (1992) might serve as a useful starting point. Both Edwards and Benhabib highlight the need to clarify and articulate what they describe as moral stances. In the case of citizen science epistemic cultures, this would include making visible the motivations, intentions and power-relations being enacted by various parties. It calls for a form of mutual accountability and transparency within the initial phases of collaboration, and an ongoing accountability towards what is made visible as the project unfolds. Benhabib's (1992) call is for such conversations to open the space for mutually negotiated pathways forwards which embrace differing priorities and interests, rather than resorting to consensus-based decision-making which homogenise goals, interests and priorities (also see Carlile, 2004). This

would require for example, the clarification of and distinctions between State mandates (which should remain the responsibility of State agents and institutions), and contributory democracy or active citizenship roles. It also calls for the development of mechanisms, practices and structures which enable citizen scientists to work with, collaborate, or hold the State accountable, rather than being placed in a position to take on State functions and responsibilities. Other questions which may be raised include:

How might the State be engaged in processes of participatory or radical democracy?

How might citizen scientists be supported to deepen and strengthen their contributions to participatory or radical democracies as ways of enacting forms of active citizenship?

Edwards (2012) and Benhabib (1992) stress the need for mutual gain in such arrangements, which encompass the need for epistemic, contributory and epistemic justices. Edwards (2011) synthesises a range of features which she suggests should be attended to when building common knowledge, (summarised in 2.4.2.). Alexander (2004) provides both an illustration of how this might be accomplished, using ToadNUTS as an example, as well as offering a social protocol which might be used to initiate and guide such a process.

7.5.3. Reclaiming Epistemic, Contributory, and Distributive Justices

Law's description of scientific processes of legitimation as ones which 'distort into clarity' (2004) (or more precisely, distort into scientific clarity), become visible by articulating sociologies of emergences, as in this chapter. What is visible as legitimate epistemic activity within the case studies is a small portion of the epistemic substance within these epistemic cultures. Scientifically legitimated accounts fail to substantively reflect processes of knowledge co-construction, nor do they comprehensively account for the plethora of epistemic outcomes generated within these ecologies. Instead, these three case studies illustrate the enactment of ontological politics (Mol, 2004), which perpetuate systems of epistemic, contributory and distributive injustices by obscuring, producing as nonexistent, and denigrating particular epistemologies, epistemic subjects, objects, practices and arrangements, as well as their outcomes. The case studies demonstrate Mol's arguments for recognising epistemic objects as overlapping knowledge objects which shift reality from activity to activity, practice to practice, value to value, depending on who is working with them, and towards which ends. We see in these case studies, how each of the tools, protocols, processes and practices enacted as

commoning, towards the generation of common knowledges, indeed enact and serve to further generate multiple forms of reality itself (Mol, 2004).

Because of this, issues of epistemic, contributory and distributive justices remain largely unattended (the *WfD* case study demonstrates how challenging it can be to enact such intentions on the ground). These cases make visible the ecologies of knowledges already being enacted within these projects, highlighting the need to articulate and strengthen systems of epistemic justice. Likewise, the clear evidence of epistemic contributions by citizen scientists, juxtaposed with their denigrated epistemic statuses and roles, and the ongoing issues related to resource distribution, acclaim, epistemic recognition, and other professional currencies, call for stronger systems of contributory and distributive justices.

What remains absent in the ecologies opened up above are coherent articulations of those ontologies only hinted at in reference to 'ancestors', indigenous knowledges, embodied knowledges, and others. They are clearly present-and-invisible, even in these re-storied ecologies. The knowledges that have become visible through this process of analysis are mainly those subjugated and encompassed on the same side of the Abyssal Line, within the first Great Divide (see 2.7.1 and 2.7.9). This calls for a greater research integrity, and stronger systems of epistemic rigour in accounting more authentically for the ecologies of knowledges within the epistemic cultures of citizen science projects.

7.5.4. Expanding Descriptions of Epistemic Cultures

In Chapter 6, descriptions of epistemic cultures drew primarily on the work of Cetina (2007) and Latour (2004). The focus was on distinguishing epistemic cultures based on the configuration of epistemic purposes, subjects, objects, practices and outcomes, for the most part. Viewing epistemic cultures through sociologies of absences and emergences enabled a more ontologically, politically astute articulation of three epistemic cultures. Issues of cognitive and distributive justice, and the possible slippages between enacting State mandates versus enacting participatory or radical forms of democracy became more visible, as did an increased power to intervene into context. These case studies demonstrated the increased power of articulating epistemic cultures through the conjoined lenses offered by Cetina (2007) and Santos (2004), increasing the rigour and 'visiblising' the ontological politics at play within such cultures.

A similar analysis - this time foregrounding a reading of case studies through conceptions of 'matters of fact' or 'matters of concern', would further enhance and strengthen articulations of epistemic cultures. This, I will leave for future research.

7.5.5. Conclusion

The epistemic cultures described above offer alternative, futures-oriented approaches to knowledge co-production that are perhaps more appropriately suited to engaging citizens and civil society in critical knowledge production activities in response to social-ecological risks, rather than seeking to encompass them in fully scientific forms of knowledge production. The three examples illustrate how bringing different knowledges into an ecology with each other, first brought situated risks into focus in multiple ways, and then enabled a range of responses in context that would not have been possible with any one knowledge alone. While the descriptions of citizen sciences here have been summarised and, to some extent, simplified, they provide a useful illustration of how the expansion of knowledge production activities outside of formalised institutional processes and the institutionally developed traditions of scientific practice (which are inclusive of wider knowledges that reach beyond traditional 'western' conceptions of science), can strengthen responses to embodied social-ecological risk. These examples challenge common-sense understandings of the role of the professional scientist in knowledge brokering activities, and highlight the potential value of knowledge co-production within ecologies of knowledges.

Here, the production of scientific knowledges is only possible through an ecology of knowledges, even as it claims a superior epistemic status to those of other knowledges within these ecologies. This analysis challenges the very notion of how scientific knowledge is produced (at least in the context of the citizen sciences), calling for a more honest account of epistemic activity, and a redistribution of epistemic statuses and the powers they afford. It also offers one path towards reclaiming epistemic diversity, and strengthening the epistemic integrity of how we account for knowledge production within systems intended to build common knowledges.

CHAPTER 8

Concluding This Study: Knowledge Propositions, Limitations, and Generative Possibilities

8.1. Knowledge Propositions, Limitations, and Generative Possibilities

In keeping with the theoretical arguments in the thesis, this chapter is written as a series of knowledge propositions (Latour, 2004; also see 2.7), which synthesise research insights. These propositions are intended to provide direction on how the epistemic cultures of citizen science projects might be strengthened to enable stronger commoning in response to social-ecological risks. Propositions arose from the various levels of theorising, immanent critiques, data analysis and onto-epistemic imaginaries engaged in the thesis, and leveraged post-abyssal notions of epistemic activity. Z

I begin with a brief summary outlining the key arguments presented across the thesis, with particular focus on the epistemic ground gained through each, before outlining key limitations of this study. I then offer a series of knowledge propositions directly related to the epistemic cultures within the citizen sciences. I conclude the study by highlighting possibilities for future research.

8.2. A Review of Key Movements in this Thesis

The citizen sciences encompass a rapidly expanding field of epistemic activity. By their very social-ecological arrangements, they challenge and reorganise established systems of knowledge production into systems more strongly geared towards the production of common knowledges. Designations of professional, lay, amateur, indigenous, policy-maker, public servant, and public are all potentially reconstituted, rearranged, and reconvened in response to situated, regional and global risks. Most significantly, what counts as a legitimate knowledge contribution is expanded to encompass a far wider region of epistemic activity than would be admitted within institutionalised systems of scientific knowledge production usually. Renewed conceptions of who count as legitimate knowers, and what counts as legitimate knowledge, emerge in the risk-responsive epistemic cultures within citizen science projects.

My intention in this piece of research was to provide a post-abyssal (re)stor(y)ing of the citizen sciences. I started by asking how the citizen sciences might support us to generate systems of commoning which enables us to (re)constitute the common good in response to social-ecological risks. Much of Chapter 1 was concerned with reconstituting relations, first between the social and the ecological, and then between citizens and the worlds we are situated within.

The critique of public good narratives was intended to shift epistemic relations - or the possibility of epistemic relations - away from the well-established, institutionalised, often hegemonic systems of knowledge production and translation, back towards more direct and connected systems of commoning. Establishing the common good and commoning as vantage points for the study provided a more generative position from which to investigate epistemic cultures which were geared towards producing common knowledges.

Three key theories were convened to bring focus to epistemic arrangements, practices and outcomes, including Cetina's epistemic cultures (2007, 1999), Latour's matters of fact/concern (2004), and Santos's sociologies of absences and emergences (2016, 2009, 2004) (Chapter 2). All three bodies of work foreground epistemic practices, context relevance and relationality. Each challenges hegemonic notions of scientific knowledge production in their own way, while providing conceptual and analytical tools to (re)search, (re)think, and (re)stor(y) knowledge production. Latour (2004) and Santos (2009, 2004) especially, forward an interest in the common good, *bien vivir*, the common good life and common good world, challenging systems of injustices which erode such goods. These three ways of analysing and describing epistemic activity were used to investigate both the field of literature and the field of practice, as well as to critique the general knowledge cultures within which specific epistemic cultures are located. Santos's work was particularly significant because it enabled a renewed perception of what counts as legitimate knowledge, encompassing all forms of epistemic activity as potentially legitimate and useful in response to specific manifest risks (2016, 2009, 2004).

In order to meet the challenge that Latour (2004) and Santos (2004) issue to expand perceptions of what counts as legitimate knowledge, and what is included as a legitimate knowledge contribution, I needed to find ways of engaging with ontological politics (Mol, 1999) within the study methodology (Chapter 4). One of the most important strategies for doing so was through an ongoing articulation of onto-epistemic imaginaries (after Verran, 1998), through which I aimed to generate new and renewed onto-epistemic openings for investigating the processes of knowledge production within the citizen sciences. A 'methodological Tango' was engaged to account for both analytical and political forms of rigour in the study, reflecting the post-abyssal interest in knowledge production, and to make such processes more visible.

Recognising that specific epistemic cultures do not exist independently of broader knowledge cultures (Cetina, 2007), I engaged imminent critiques of three interrelated knowledge cultures which strongly influence citizen science knowledge practices (Chapter 3). The first critique focused on dualistic ontologies within western scientific forms of knowledge production. The interest was in more clearly understanding how dualistic rationality enabled the production of particular epistemic outcomes while rendering others nonexistent. The bases of this distinction were challenged because they undermined knowledge production as commoning in response to social-ecological risks, and as perpetuating epistemic violences in ways that were ontologically dissonant. The second critique brought attention to knowledge translation processes between science and its publics, which enacted dualistic rationalities into the sphere of applied knowledges, governance and public administration. Here, the interest was in considering the institutionalised systems of knowledge production and translation which mediated relationships between institutionalised scientific knowledge production and diverse publics. Hegemonic systems of epistemic relations were challenged as potentially undermining deliberative, participatory and radical forms of democracy, and further perpetuating social and epistemic injustices. The third critique focused on the construction of social-ecological risks as anthropocentric in nature. Again, hegemonic rationalities informing dominant arguments in the field were challenged as perpetuating and further entrenching the social and epistemic injustices enacted through dualistic rationalities. I argued that dualistic articulations of risk undermine the recognition and articulation of relational causes of risk, effectively obscuring risk generating relations, and undermining effective risk-responsive commoning.

The three critiques, together, highlight tendencies within general knowledge cultures which perpetuate dualistic ontologies and the resultant epistemic violences, and give rise to a hegemonic system of knowledge production predisposed to dualistic forms of epistemic activity. This perspective is important because it makes visible some of the systems of produced nonexistence which naturalise particular ways of legitimating knowledges while delegitimizing others. Bringing epistemic systems, processes and practices which produce nonexistence back into view, generates opportunities for renewed onto-epistemic imaginaries about the ways in which we might, and actually do, produce knowledges in response to social-ecological risks.

The immanent critique of peer-reviewed literature (Chapter 5) provides insight into legitimated knowledge production within the scientific community. Scientific reporting is itself, an epistemic

process of knowledge production whose analysis provides insights into one aspect of the epistemic cultures of the citizen sciences. Peer-review and publication can be perceived as one of the most significant legitimating practices of scientific knowledge production, and therefore considered a key epistemic practice. Scientific reporting in the form of peer-reviewed literature can also be perceived as constituting dominant narratives within general knowledge cultures. An immanent critique of literature was engaged to more closely examine how knowledge was being reported, as well as enactments of produced nonexistence. This critique was formulated when it became evident that many scientific accounts of knowledge production differed in significant ways from epistemic processes observed within the applied contexts of citizen science projects. Through this critique, I was able to make visible two broad groupings of scientific reporting, and the forms of knowledge production each was oriented towards. Latour's articulations of 'matters of fact', and how they differed from 'matters of concern' helped to make visible how modernist scientific knowledges were being produced in response to diverse social-ecological risks (2004). In addition, hegemonic accounts and post-abysal expansions of knowledge production also became visible, as did their conceptions of collective knowledge production and other forms of commoning. Of particular significance were the 'knowledge cleaning' (after Law, 2004) practices evident within many accounts.

The epistemic mapping of the field of practice provided insight into specific epistemic cultures, informing articulation of a landscape of knowledge production practices, including a macro view of epistemic features and relationships (Chapter 6). A range of epistemic tendencies were identified, aligning with epistemic purposes and institutional arrangements. Of particular interest were the ways in which different approaches to knowledge production were more strongly geared towards the production of 'matters of fact' or 'matters of concern', and the ways in which each approach enabled distinct mobilisation of knowledge in response to social-ecological risks. Projects producing 'matters of fact' enabled the production of more strongly legitimated scientific knowledges which were more easily perceivable by knowledge-mediating institutions - be they academic or governance institutions, and mostly mobilised through such mediating institutions. While projects generating 'matters of concern' seemed to generate more complex forms of knowledge which were mobilised in more generatively diverse ways. Issues of epistemic, contributory and distributive justices were more likely to be engaged in the generation of 'matters of concern', compared to the production of 'matters of fact', and epistemic statuses, roles and relationships reflected these differences. A key outcome of the

epistemic mapping process was that it led to the development of a relational heuristic of epistemic practices (see Figure 29).

In-depth analysis of three illustrative case studies provided more refined investigation into the epistemic cultures of citizen science projects (Chapter 7). Here, Santos's sociologies of absences and emergences played a critical role in helping to articulate a range of epistemic roles and contributions, and how they were convened into ecologies of knowledges which arose out of, and enabled response into, contexts of situated social-ecological risk. The case studies made evident the complexity of epistemic activities and the contribution of a range of knowledges facilitating the production of common knowledges. Additionally, various forms of epistemic expertise were highlighted, and shown to be significant in knowledge production processes. Through this analysis, the role of citizen scientists as more than data contributors or scientific knowledge workers was made evident. Each of the three epistemic cultures investigated convened ecologies of knowledges which included scientific, governance and situated knowledges (among others). However, the analysis highlighted that the reasons for including these forms of knowledge, the mechanisms for convening them, and the ways in which they enabled or hindered the mobilisation of produced common knowledge in response to particular manifestations of social-ecological risks, differed significantly. The role of science itself shifted from project to project, as did its epistemic status. Once again, issues of epistemic, contributory and distributive justices were highlighted, as was a tendency for hegemonic institutions to erode potential mechanisms for participatory and radical democracy while reallocating citizens' resources to fulfil institutional mandates. This level of analysis highlighted the generative relationships between ecologies of knowledges, the generation of 'matters of concern', and the ability to leverage produced common knowledges in response to particular instances of manifest risk. This level of analysis highlighted inherent possibilities for the citizen sciences to offer a range of knowledge-informed mechanisms of participatory and radical democracy - especially when oriented towards the generation of common goods.

Finally, the articulation of rigour-as-integrity in Appendix 11 reaffirms an orientation to research which centres an interest in research-as-commoning, in ways which reclaim ontological politics, onto-epistemic imaginaries and epistemic justice. The think-piece synthesises insights about engaging post-abyssal research approaches which became evident during the course of this

study. The think-piece is an invitation to produce more coherent accounts of knowledge production within the domain of professional scientific practice and the citizen sciences.

8.3. Limitations of this Research

A range of limitations, exclusions and incomplete arguments are described throughout this text and in related footnotes. Here, I summarise some of the larger limitations to this study.

8.3.1. Methodological Limitations

Sampling: As noted in 6.11, the approach to project sampling for epistemic mapping was unintentionally biased towards projects with online presences and academic or government affiliations. Community-based, grassroots, and highly localised projects remained largely undetected. This resulted in a skewed data sample favouring species mapping and resource management projects, which tend to have institutional affiliations, and are more visible in digital and academic forums.

Exclusion of direct citizen science voices: Interviews were limited to project managers, and excluded citizen scientists. Project managers were identified as the most suitable candidates to articulate various epistemic features and relationships, but later analysis indicated that citizen scientists do not necessarily perceive epistemic activity in the same ways project managers do. Nor are project managers engaged in the full range of informal, unofficial or expansive epistemic activities often engaged by citizen scientists themselves, as they seek to enable the generation of scientific data, or take up research findings into applied contexts. The *ToadNUTS* case study illustrates this possible tension clearly. The epistemic justice and post-abyssal arguments within this study highlight the exclusion of citizen science voices as a significant weakness in political rigour.

Researcher as primary epistemic subject: Resonating with many institutionally organised citizen science projects, in this study, I am the primary epistemic subject. I have proposed a theoretical framework which orients knowledge production towards my own professional priorities, and the epistemic priorities of the field of practice within which I am located. I analysed and synthesised various forms of data, and drew epistemic conclusions on behalf of the diverse research participants (both those who were given voice and those who were

produced as silent). This process of knowledge production is one that is critiqued repeatedly in the thesis, and highlights another dimension of weak rigour in the study.

8.3.2. Theoretical Limitations

Sociologies of absences: Santos's sociologies of absences include five forms of produced nonexistence and five ecologies, in response. My analysis primarily focused on ecologies of knowledges as ways of articulating the epistemic cultures within the three case studies. Although peer-reviewed literature was analysed for all five modes of produced nonexistence and ecologies, the analysis was general, rather than substantive. While epistemic cultures, and therefore knowledges, were the primary focus of this study, I also recognise that each of the ecologies within the sociology of absence account for different, yet interrelated dimensions of social and epistemic justices, and inform how knowledge is produced and legitimated.

8.4. Knowledge Propositions Emerging from this Study

In this section, I offer a series of knowledge propositions emerging from the various research processes engaged in this study. In keeping with Latour's arguments (2004, also see 2.7.3.), the propositions proposed below are neither true nor false in the way that knowledge is made factual within hegemonic systems of scientific knowledge production. Instead, they are intended to hold visible and present, what has been evidenced, formulated and articulated in relation to particular 'matters of concern', inviting ongoing review, re-articulation and challenge as new insights become available. They are neither fixed, nor relieved of their responsibilities for better and improved articulation. Propositions are holding spaces for what has come to be known, until we are able to know more. The articulation of both limitations to the study (9.3) and possibilities for future research (9.5) make evident the provisional nature of the knowledge produced here.

8.4.1. Generating General Knowledge Cultures for Producing Risk-Responsive

Common Knowledges

I offer the following knowledge propositions about how we might better generate and strengthen general knowledge cultures responding to social-ecological risks.

- **Proposition 1:** Building and maintaining knowledge commons appears to require a range of commoning activities which are more strongly served through knowledge production systems geared towards engaging 'matters of concern', rather than establishing 'matters of

fact'. This is demonstrated through the analysis offered in Chapters 6 and 7 especially. Generating 'matters of concern' enables a more visible enactment of ontological politics, while foregrounding possibilities for intervention into context.

- **Proposition 2:** Hegemonic framings of risk which are underpinned by dualistic ontologies are hazardous because of the path dependencies they engender. The separation of knowledge and associated attribution of risk, in ways which separate out social and ecological risks and injustices, undermine relational responses which recognise risks as manifesting in the same universe. Relational framings offer potentially stronger generative opportunities in ways which reconnect knowledge production and application, and nature and society.
- **Proposition 3:** Conceptions of dualistic scientific knowledge production are concerning in that they undermine the possibilities for both generating common knowledges, and enabling stronger modes of epistemic, contributive and distributive justices in relation to knowledge production. The hegemonic systems of scientific knowledge production which have become institutionalised tend to mask systems of injustice and naturalise false epistemic hierarchies, strengthening particular forms of knowledge production and denigrating others. This is especially significant in the context of knowledge production in response to manifest social-ecological risks (see Chapter 7).
- **Proposition 4:** Deliberative, participatory and radical democracies seem to be more strongly enabled through epistemic cultures which foreground relational systems of commoning (rather than mechanised and strictly delimited data collection and analysis tasks or predetermined science-public interactions). Such approaches enable a wider range of epistemic subjects to both constitute and mobilise knowledges in ways that also interact with established (hegemonic) systems of knowledge production and translation (see evidence of this in Chapter 7). Articulation of common goods, and establishment of systems of commoning require epistemic cultures geared towards generativity.
- **Proposition 5:** It seems as though common goods cannot be separated out from the interconnected dimensions of epistemic, contributory and distributive justices. Common goods are constituted through commoning, and commoning requires coherent systems of justices. Again, Chapter 7 illustrates the implicated natures of these forms of justice, the condition of common knowledges and the potential to leverage those knowledges towards the constitution of various common goods.

- **Proposition 6:** Forms of knowing which are not aligned with, or able to be legitimated through scientific sorting processes, remain largely invisible within general knowledge cultures, and therefore require focused articulation and reclamation. More robust systems of knowledge legitimation are required within the institutional settings which mediate knowledge production and translation.

8.4.2. The Citizen Sciences as an Epistemic Landscape

The following propositions are articulated to describe the epistemic landscape of citizen sciences.

- **Proposition 1:** It is inaccurate to describe a field of *citizen science* (singular); more accurately, as this thesis has demonstrated, the *citizen sciences* (plural) encompass a range of complex and highly differentiated systems of epistemic activity. Referring to this diversity of approaches as the citizen sciences enables a more appropriately differentiated discussion of, and investigation into the ways in which knowledge is being produced, legitimated, and mobilised, as well as more precise articulation of which approaches are better suited to particular knowledge requirements. Chapters 6 and 7 evidence and inform this proposition through the articulation of a wide range of epistemic cultures, purposes and outcomes which are each geared towards the production of common knowledges and the translation of those knowledges within diverse epistemic cultures.
- **Proposition 2:** Each approach to citizen science leverages scientific knowledges in particular and distinct ways. Therefore, the epistemic roles and enactments of science cannot accurately be conflated into a single science. Discussions of scientific legitimacy can likewise, no longer be applied to the entire field of practice, but must be engaged on a project-to-project basis, with only the discussion of general tendencies possible across larger scales. Both Chapters 6 and 7 evidence this tendency. Chapter 6 makes visible the different purposes towards which scientific knowledges are being leveraged, while Chapter 7 highlights the significance of both when and how scientific knowledges are leveraged in different projects.
- **Proposition 3:** Within the citizen sciences, knowledge is mobilised in different ways in response to diverse social-ecological risks, and depending on the motivations of those engaged in knowledge production activities. The purpose of every citizen science project is evidently not the production of scientific knowledge, but rather encompasses a range of epistemic outcomes, including applied management, advocacy, forms of participatory or

radical democracy, the production of scientific knowledge, the production of situated knowledges, governance and resource management, and many others. Different approaches enable engagement with diverse forms and scales of social-ecological risks. Chapter 6 articulates such tendencies across projects, and Chapter 7 demonstrates the complexity of epistemic motivations and knowledge mobilisation within projects (see 7.2.5 - 7.2.7; 7.3.8 - 7.3.10; and 7.4.7 - 7.4.9).

8.4.3. The Epistemic Cultures of Citizen Science Projects

A number of insights about specific epistemic cultures are articulated in Chapters 6 and 7. Here, I offer general insights about the configurations of epistemic cultures more broadly.

- **Proposition 1:** As attested through interviews and project reports, the epistemic cultures of citizen science projects appear to be generative, encompassing a range of officially recognised and unrecognised knowledges, epistemic processes, and practices. Generativity is increased, and more integrated and relational systems of commoning enabled, when epistemic cultures are oriented towards the production of 'matters of concern', although generativity can be observed even within projects oriented towards the production of 'matters of fact'. In part, this may be due to the interaction and overlap of both closed and open systems of knowledge production. Chapter 6 provides insight into this across a landscape of practices (and specifically 6.10), while Chapter 7 demonstrates the enactment of these tendencies within three particular projects in more detail.
- **Proposition 2:** The epistemic cultures of citizen science have a tendency towards expansive activity and generativity. In projects strongly delineated by scientific protocols, such expansive activity and generativity emerges in unofficial and/or informal social interactions. In projects which enable more collaborative processes of knowledge production, this tendency manifests within formal project activities as well as expanded systems of activity informed by common knowledges being produced through project activities (see Chapter 6, and especially 6.9 and 6.10).
- **Proposition 3:** Not all epistemic activity is accounted for in formal project reports. Therefore, project reports provide an incomplete record of epistemic processes contributing to knowledge production (as evidenced in a range of articulations in Chapters 5, 6 and 7).

8.4.4. Strengthening Production of Pluriversal, Just Knowledges

The following propositions speak more directly to the production of pluriversal and just knowledges within the citizen sciences (recognising that pluriversality does not ensure justice - epistemic or otherwise).

- **Proposition 1:** As demonstrated in Chapter 7, ecologies of knowledges seem to contribute to knowledge production in diverse and substantive ways across a range of citizen science approaches. Ecologies of knowledges influence the ability to mobilise common knowledges produced in projects in response to specific manifestations of risk.
- **Proposition 2:** Scientific knowledges play a range of epistemic roles depending on how they are convened into a particular ecology of knowledges. While each citizen science ecology leverages scientific forms of knowledge production, it is inappropriate to centralise science as the core component of such ecologies. Based on the cases reviewed, situated or governance knowledges are as likely to be core knowledges¹³². Other ways of knowing are as likely to be foregrounded, depending on the epistemic purposes of a project. The epistemic maps in Chapter 7, in particular, demonstrate the diverse ways in which projects are working with scientific knowledges, and the range of roles such knowledges assume.
- **Proposition 3:** The epistemic cultures of citizen science projects are constituted through ecologies of knowledges which are convened in unique, risk-responsive systems of epistemic activity. The articulation of social-ecological risks within a particular project determines which knowledges are convened, for what purposes, and in which order. Ecologies can therefore not be separated from the risks to which they are responding. Again, Chapter 7 evidences the diverse ways in which three projects have been constituted in response to social-ecological risks across contexts and scales within each project.
- **Proposition 4:** By and large, scientific reporting of epistemic activities within accredited reporting structures is imprecise and incomplete because it 'cleans out' any other knowledges being leveraged in knowledge production activities, and foregrounds primarily scientific forms of legitimacy and rigour. Administrative reporting within State projects (and possibly other forms of official reporting) have the same tendency. Currently, such forms of reporting entrench and perpetuate systems of epistemic injustice through systems of rigour which delegitimize non-scientific forms of epistemic activity. Strengthening epistemic, contributory and distributive justices require more rigorous approaches to scientific and

¹³² This calls into question the appropriateness of the term 'citizen sciences' to describe this landscape of epistemic practices. This is an ongoing debate within the field of literature. For now, the inclusion of scientific knowledges offers a measure of coherence to the term. (Eitzel *et al.* (2017) offer a careful engagement with this issue).

governance reporting, which intentionally make visible the epistemic contributions of all epistemic subjects who have contributed to common knowledge production. The review of literature in Chapter 5 evidences the tendency to 'clean out' ecologies of knowledges.

- **Proposition 5:** Scientific forms of rigour are not sufficiently robust for legitimating knowledge produced through ecologies of knowledges, and in response to 'matters of concern'. The development of systems of rigour which engage both ontological politics and analytical rigour are required in systems of common knowledge production. This argument has been built throughout the thesis, and is evidenced in the tensions between diverse forms of knowledge production, epistemic motivations and epistemic subjects in Chapter 7.

8.5. Possibilities for Future Research

I adopted a generative research approach to this study, resulting in a wide range of future research possibilities. Through this research, the potential for the citizen sciences to become a methodology which enables participatory and radical forms of democracy becomes evident. The epistemic arrangements of citizen science projects also offer potential structures for strengthening epistemic, contributive and distributive justices, while enhancing our collective abilities to respond to manifest social-ecological risks. This opens up a wide range of possibilities for future research; three starting points are highlighted here:

- This study provides an epistemic starting point for analysing citizen science practices. Based on initial findings about knowledge mobilisation, research focusing on epistemic mapping of knowledge production through to knowledge translation and into application, will provide greater insight about how to strengthen alignment across diverse institutions and publics.
- As noted in Chapter 5, defining a field of citizen science remains contentious and ambivalent because of the diverse epistemic systems of activity encompassed under that title. Investigating how science is produced, why it is being produced (i.e. the role it is intended to play), and how it is being mobilised in response to risk, might provide a more coherent way in which to distinguish and partially define various approaches to citizen science, as well as contribute to a deeper understanding of the field of practice. If science is to be a defining feature of the citizen sciences, then it is important to understand its roles, and associated responsibilities.
- As noted earlier, one of the limitations of the analysis in this study was its focus on ecologies of knowledges. Analysing practice for all five modes of produced nonexistence, as well as articulating each of the five ecologies included within the sociology of absence would

enable a more robust understanding through which to strengthen systems of justice within citizen science projects, as well as facilitating better use of what Santos describes as 'wasted social experience', (2004).

- State institutions are integrating increasing numbers of citizen science projects into their mandated activities. As evidenced in Chapter 7, there is a danger that this might result in a divestment of State responsibilities onto citizen scientists. Chapter 7 further evidences the potential to enhance State-mandated functions, and strengthen participatory and radical forms of democracy, thereby expanding State functions to include citizen science approaches. Researching the institutional cultures and systems of production and translation of common knowledges into governance applications will enable a more robust understanding of possibilities and dangers. It would also inform how we might better align State systems to citizen science-oriented forms of participatory and radical democracy.
- Issues of epistemic discrimination as regards the legitimacy of diverse knowers and their knowledges are important in the context of commoning as contributions to social-ecological risks, and the forms of justice related to such commoning. However, this thesis has not yet provided sufficiently clear arguments to defend the somewhat normative claim that all knowers should be acknowledged as holding potentially valid and legitimate knowledges, and be afforded the opportunity to contribute such knowledges towards the resolution of social-ecological risks affecting them. While the work of this thesis contributes a beginning to this argument, further careful articulation is required to substantiate the claim more fully.
- Finally, due to the complexity of both the theoretical framework and the research methods adopted, it was not possible to carefully define and substantively defend a number of terms and normative positions adopted in the thesis. I have needed to be selective about which definitions to clarify, and which arguments to provide substantive justification for due to the length of the thesis. Further critical reflection on some of the 'established truths' underpinning key arguments in the thesis would be beneficial, including a deeper engagement with notions such as 'hegemonic', 'neoliberal', 'structures', 'systems', 'hegemonic neoliberal globalisation, and 'justice'. They currently have a tendency towards appearing as though they hold fixed ontological status, which is inaccurate. Further definition of these terms would contribute to the intellectual coherence of this body of work.

8.6. Last Word: A Working Definition for the Citizen Sciences

As highlighted across various forms of analysis in this study, and also reflected in the peer-reviewed literature, there is as yet no coherent definition for the citizen sciences which remains coherent and just across epistemic cultures. I end this thesis by joining into the discussion about definition and offering a proposition which contributes to the formulation of a more coherent and just articulation of what citizen science is, epistemically speaking.

The citizen sciences (plural) are a field of epistemic practices which convene diverse ecologies of knowledges in response to social-ecological risks across various scales. Each ecology of knowledges leverages at least one form of scientific knowledge in its ecology, although the purpose for doing so and the way that it is done varies from project to project, and scientific knowledge production is not always a priority. The epistemic cultures within the citizen sciences are geared towards the production or generation of diverse forms of common knowledge, some through the production of 'matters of fact' and others through the generation of 'matters of concern'. The bases of legitimation vary from project to project, and include both internal and external systems of legitimation, depending on the knowledges included.

Each epistemic culture convenes a range of epistemic institutions in different ways, sometimes collaboratively, at other times, antagonistically, depending on the intended epistemic outcomes in relation to manifest social-ecological risks. Epistemic roles and statuses also shift and expand, from epistemic culture to epistemic culture. The epistemic cultures of the citizen sciences tend to be expansive and generative in nature, meaning core epistemic activities generate and expand into new epistemic activities and applications of common knowledge produced through formal project activities. The citizen sciences encompass multiple ways of knowing, producing knowledge, and responding to social-ecological risks.

All beginnings are also endings. And all endings bring with them, new beginnings.

It matters which beginnings begin renewed beginnings.

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APPENDIX 1: RESEARCH ETHICS - INFORMED CONSENT FORM



EDUCATION DEPARTMENT

Tel: +27 (0)46 603 8383 • Fax: +27 (0)46 603 8028 • PO Box 94 Grahamstown 6140 • E-mail: education@ru.ac.za

Dear Research Partner,

RE: Introduction of Rhodes PhD candidate, Priya Vallabh, and her study on Citizen Science Practices in South Africa

This letter serves to introduce Miss Priya Vallabh, a doctoral candidate studying at the Environmental Learning Research Centre (ELRC) in the Department of Education at Rhodes University, under my supervision.

Priya is conducting a PhD study entitled: *Epistemic access to developing foundational science learning and skills in the biodiversity sector ... are the rumours about online / blended citizen science projects true?*

We hereby formally request permission for Priya to contact and conduct research with students and employees within your organisation working on Citizen Science projects. The first phase of the project has a time commitment of a 1-hour interview per project (telephonic, or in person where possible) or participation in an online survey (depending on the participant's preference).

The study aims to research the ways in which online / blended citizen science projects facilitate or impede epistemological access to foundational science knowledge and skills (A more detailed outline of the study and additional time commitments is included in *Appendix 1*). It responds to a lack of robust research on the educational value and contribution of citizen science projects both within South Africa, as well as more broadly, internationally. The study hopes to support and inform the development of citizen science practices – specifically supporting the development of this innovative approach to scientific learning and skills development – within the field of practice.

Priya's research proposal has been approved by the Rhodes University Education Higher Degrees Committee, and obtained ethical clearance from the Ethics Committee. The research will focus on the learning cultures of projects, rather than on the work of individuals within projects, and anonymity of participants (and/or projects) will be negotiated upfront. All findings will be returned to participants for member-checking after each phase of the study. A copy of Priya's proposal is freely available on request.

We look forward to working with you in this exciting research project. Please do not hesitate to contact either Priya (priya@ecoskills.co.za / 073 865-9985) or me should you require further information about this study.

With regards,

Heila Lotz-Sisitka

Professor

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APPENDIX 1: STUDY OVERVIEW

Two significant biodiversity sector reports responding to skills development needs within the sector inform the focus of the study:

- a) The Human Capital Development Strategy for the Biodiversity Sector in South Africa (HCDS), and*
- b) The Culture, Arts, Tourisms, Hospitality and Sport Sector Education and Training Authority (CATHSSETA) Sector Skills plan.*

Both reports strategise skills development in a variety of ways, including by identifying a number of scarce science and technology-related skills linked to key occupations. The term ‘skills’ is used to describe a combination of knowledge, values and skills, which enable individuals to do their work.

Scarce skills are associated with specific occupations that are in short supply. The HCDS additionally identifies a list of critical skills or skills required within occupations that are integrative and supplement core biodiversity-related knowledge and skills, and are essential to an occupation (technical and integration skills; communication, knowledge brokering, advocacy and social learning skills, and the ability to work in contexts of uncertainty and complexity). The reports also highlight a variety of barriers limiting transition from tertiary education into the workplace. These multiple scarce occupations speak to a need to foster learning spaces and strategies that enable epistemological¹ access to the foundational science learning and skills that would enable learners to access first tertiary education, and then careers that build on these skills to access them.

Priya’s research aims to provide insight into the forms of epistemological access currently embedded in citizen science projects in South Africa through the following approaches:

- Mapping the context of practice in South Africa (with special focus on the educational and participatory orientations of projects);
- Carefully working with a range of tools to map the learning and disciplinary cultures of a range of projects through researching mediating artefacts, relationships between project participants, and examining the disciplinary and ideological underpinnings of a variety of projects.

The study will be conducted in three phases:

- **Phase 1** – A national survey of citizen science projects in South Africa (a short 30-40 minute telephonic interview / online survey, depending on partner preference);
- **Phase 2** - A document and online portal review of selected case studies (including in-depth critical discourse analysis of project web-portals);
- **Phase 3** – In-depth interviews with project managers / developers.

(A copy of Priya’s full research proposal is available on request).

¹ Epistemological access here refers to access to disciplinary forms of knowledge.

APPENDIX 2: RESEARCH ETHICS - INFORMED CONSENT FORM

Permission Form

Citizen Science Demographic Mapping

Administered by Priya Vallabh

priya@ecoskills.co.za

Participant name: _____

Project name: _____

All *personal* information collected through this mapping tool will be kept confidential, and will only be used to support researching and improving Citizen Science projects.

I hereby request permission to use the *demographic* information collected in this mapping tool to build a public database of citizen science projects active in South Africa. The database will be made available to all citizen science projects and researchers, and possibly shared through a public website supporting citizen science projects. The database, and related works will be maintained under an Creative Commons [Attribution-NonCommercial 4.0 International](https://creativecommons.org/licenses/by-nc/4.0/) license.

This means that the information and work generated through the mapping will be freely available for:

- Copying, redistribution and sharing;
- Remixing, transformation, and building upon.

Limitations include:

- Attribution - the original work must credited, with indication of any changes made (and in acknowledgement that changes are not endorsed by the original researcher). The research maintains her intellectual property rights over the original work;
- The research and work created is not available for commercial purposes. Instead, it is licensed under the [Attribution-NonCommercial 4.0 International](https://creativecommons.org/licenses/by-nc/4.0/) license to support further work in this area, in development of the Citizen Science community of practice.

Projects can opt out of being listed in the public database, in which case information will be used solely for the current research study. The projects name will be added to the database, with no information attached.

Please include us in the database.

☐

We prefer not to be included in the database.

☐

Name: _____

Date: _____

Signature: _____

Appendix 4 Pilot Analytical Tool

A. Descriptive Interpretation:

(The frame of the text; the visual organisation of the text; the topic, the genre, the preferred reading and the ideal reader (which the reading position of the text suggests))

Point of Analysis	Interpretation	Notes
A1. What is the frame of the text (i.e. What elements are part of this text)?		
A2. What's the genre (e.g. advertisement, news report, narrative, political statement, notice etc.)?		
A3. What is the topic?		
A4. How is the topic being presented (e.g. formal, informal, persuasive, aggressive, angry, friendly, humorous, comic, etc.)? (cf. interpersonal meanings)		

Point of Analysis	Interpretation	Notes
A5. What is the preferred reading (the main message of the text; the reading which accords with the way the text seems to want to be read; the reading of minimal consensus)? (“reading with the text” Janks)		
A6. Who might be the ideal reader of this text? E.g. A person who ...		
A7. Any gaps / omissions, etc.		

B. Representative Interpretation:

(Interpretation of the image, grammar, vocabulary and genre choices of the text).

Point of Analysis	Interpretation	Notes
<i>IMAGE</i>		
B1. How is the text organised visually? For example, does the text use words and pictures? If so, what is the balance between words and pictures?		

Point of Analysis	Interpretation	Notes
B2. If the text is a combination of visual and written modes, or is written in a variety of formats, what is on the left (in the given position)? What is on the right (in the new position)? What is located in the upper part of the text (in the ideal position)? What is located in the lower part of the text (in the real position)? (cf. ideational, interpersonal and textual meanings)		
B3. What are the effects of these choices on the text?		
VOCABULARY		
B4. What kind of vocabulary is used in the text? E.g. formal/informal, positive/negative, casual/dramatic, emotional/serious (cf. interpersonal meanings)		

Point of Analysis	Interpretation	Notes
B5. What semantic fields (word families) do vocabulary choices belong to? (cf. ideational meanings)		
B6. What vocabulary is associated with the participants in the text? Do these choices create a particular impression of the participants? (cf. interpersonal meanings)		
B7. Is there any vocabulary which seems very important? (cf. ideational meanings)		
B8. What words are given capital letters, italicised, underlined, put in inverted commas? (cf. interpersonal meanings)		

Point of Analysis	Interpretation	Notes
B9. What are the effects of these choices on the text?		
GRAMMAR		
B10. What tenses are used in the text? Do any of these seem very important? (cf. ideational meanings)		
B11. Does the text use ‘we’, ‘you’ or ‘I’? When and how does the text use them? (cf. interpersonal meanings)		
B12. What modal verbs are used (e.g. should, must, could, can, etc.) (cf. textual meanings)		

Point of Analysis	Interpretation	Notes
B13. Are there any nominalisations in the text? When are they used? (cf. textual meanings)		
B14. When are active and passive constructions used? Are there any common themes attached to the use of these different voices? What is usually foregrounded or backgrounded in these constructions? What types of agents are used – people/ things? (cf. textual meanings)		
B15. In the text as a whole which information is put first? What is thematised? (cf. textual meanings)		
B16. What are the effects of these choices on the text?		
GENRE		
B14. Is there mixing of genres?		

Point of Analysis	Interpretation	Notes
B15. If there is mixing of genres, what are the effects of these choices on the text?		
B16. Any gaps / omissions, etc.		

C. Social Interpretation:

(The social context(s) which the text seems to be a part of: e.g. contexts of gender, race, disability, economy, politics, family, class, income, age, sex, property, geography etc.)

Point of Analysis	Interpretation	Notes
C1. What social frameworks is the text a part of (e.g. gender, race, economy, business, politics, family, class, income, age, sex, property, geography, etc.)?		(in South Africa, mainly white, middle and upperclass citizens??)
C2. What typical kinds of social knowledge do these frameworks suggest? (cf. ideational meanings)		
C3. Any gaps / omissions, etc.		

D. Deconstructive Interpretation:

(Aspects of the descriptive, representative and social dimensions of the text which appear to contradict or undermine the preferred reading).

Point of Analysis	Interpretation	Notes
D1. Does any aspect of the text's internal structure (descriptive, representative, social) appear to contradict or undermine the text's preferred reading?		
D2. Any gaps / omissions, etc.		

E. Critical Self-Reflection:

Point of Analysis	Interpretation	Notes
E1. My critical reflection on the analysis: where am I coming from? How am I socially positioned? What are my biases here? What don't I know enough about? What are my own gaps in knowledge?		

This section of the survey aims to collect demographic information for each project.

What is your project's public name (e.g. the name used on websites and project correspondence)?

This information will only be used by the research group to follow up on research-related details.

Contact details will be kept strictly confidential and only used for follow up queries related to the research study.

[illegible]

Email address:									

[illegible][illegible]

A general geographical location is acceptable (e.g. South Africa, California or Bangkok).

[illegible]

This portion of the survey aims to collect information on your project's main attributes.

For example, water quality, biodiversity monitoring, mammals, birds, etc.

[illegible]



B2. How many citizen scientists do you have participating in your programme currently?

0 - 20 participants ☐

21- 50 participants ☐

50 - 100 participants ☐

100 - 200 participants ☐

200 - 500 participants ☐

500 - 1000 participants ☐

1000 - 5000 participants ☐

10 000+ participants ☐

50 000+ participants ☐

100 000+ participants ☐

B3. Participant demographics: Who is participating in your project?

We would like to know who is contributing to your programme and helping to make it successful.

School children ☐

Teachers ☐

Tertiary students ☐

Environmental clubs ☐

Formal project partners ☐

Scientists ☐

Conservation managers ☐

Participation is open to everyone ☐

Other (please specify) ☐





B8. How many different organisations are affiliated with this project?

Please include both formal and informal partners (or area-specific partners).

B9. What is the diveristy of organisations / institutions affiliated with this project? Please provide a brief description of the nature of your relationship where possible. Tick all that apply:

We would like to understand who you are collaborating with to implement and support your project in different ways. Descriptions could include: funder, local node support, education partner, policy / advocacy partner, implementation parter, design partner, structural partner, government partner, conservation partner, etc.

Government (International e.g. UN) ☐

National government ☐

Provincial government ☐

Local government ☐

Academic institutions (international) ☐

Academic institutions (local, provincial, national) ☐

Non-profit (international) ☐

Non-profit (local) ☐

Corporate (international) ☐

Corporate (local) ☐

Educational (schools) ☐

Educational (other) ☐

Local interest groups ☐

International funding agencies ☐

National funding agencies ☐

Other organisations (please specify) ☐

Other organisations (please specify) ☐

Other organisations (please specify) ☐



Section C: Project intentions

This section is designed to help us understand what you hope to achieve through your citizen science project.

C1. What is the purpose of your project? (What does your project aim to achieve?)

In other words, what the key project outcomes you hope to achieve? For example, ecosystem monitoring, species monitoring, education, conservation, scientific research, etc.

C2. Please list your key project activities.

Please include only those activities that your project is currently engaged in.

Species mapping ☐

Species monitoring ☐

Ecosystem mapping ☐

Ecosystem / ecosystem services monitoring ☐

Recreational monitoring activities ☐

Education & training ☐

Awareness-raising ☐

Advocacy ☐

Other (please specify) ☐

C3. Please list the INTENDED scientific benefits of your project.

Please only list those scientific benefits that your project was designed to achieve (and exclude those that are assumed).

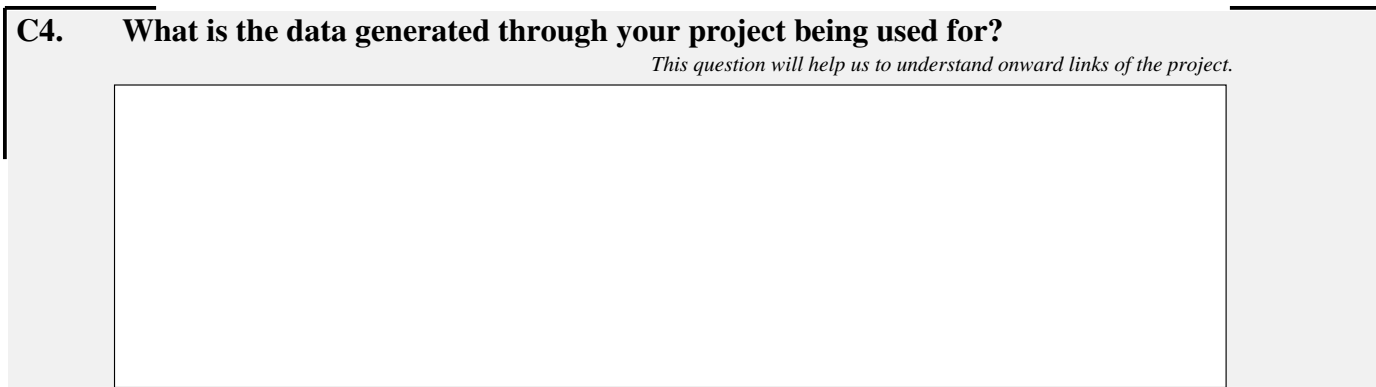
Coverage of large spatial scales ☐

Collection of long time series of data ☐

Collection of data from private land ☐

Collection of labour-intensive data that would otherwise be expensive to collect ☐

Other (please specify) ☐



Section D: Education and training of citizen scientists

In this section, we hope to gain an understanding of any education and training activities you are engaged in.

D1. Does your project engage in training or education activities?

Yes ☐

No ☐

D2. **What educational activities does your project engaged in?**

Please list any educational activities - even if they only happen sporadically or once a year.

Activity 1 description	
Activity 2 description	
Activity 3 description	
Activity 4 description	
Activity 5 description	



D3. What training activities are supported through your project?

Training refers to focused and formalised skills development activities that help volunteers to monitor or collect data.

Training activity 1 ☐

Training activity 2 ☐

Training activity 3 ☐

Training activity 4 ☐

Training activity 5 ☐

Section E: Approaches to data generation and collection

This section focuses on understanding your approaches to data generation and collection.

E1. Please provide the number of species / locations being monitored by your project.

This will help us to better understand the scale of your research.

A single species / resource / site ☐

2 - 20 species / resources / sites ☐

21 - 50 species / resources / sites ☐

50 - 100 species / resources / sites ☐

100 - 200 species / resources / sites ☐

200 - 500 species / resources / sites ☐

Unlimited species / resources / sites ☐

Other (please specify) ☐

E2. What data collection resources does your project provide?

What tools have you create or made available for data collection?

Hardcopy data sheets ☐



Section F: Conservation outcomes

This section of the survey aims to collect information about the conservation impacts and outcomes of your project.

F1. What are your project's intended / hoped for conservation impacts?

Which conservation impacts was your project designed or adapted to address? These could include (but are not limited to) protected area management; public area management; resource or species-based advocacy, etc.

Conservation impact 1	
Conservation impact 2	
Conservation impact 3	
Conservation impact 4	
Conservation impact 5	
Other (please specify)	

F2. What are the conservation impacts of your project to date?

Please only include those conservation impacts that have already been partially or fully achieved. Any conservation impacts that you aim to or hope to achieve can be added to the previous question.

Conservation impact 1	
Conservation impact 2	
Conservation impact 3	
Conservation impact 4	
Conservation impact 5	
Conservation impact 6	

F3. Write any other comments or insights related to conservation impacts here.

This area is provided in case you would like to note any particular conservation-related details not captured in the previous questions.

Section G: Citizen Scientist and Volunteer Participation

This section of the survey is aimed at helping us to understand how your programme supports participation in various programme elements.

G1. Which areas of participation for citizen scientists does your project support?

How are volunteers able to participate in your programme (e.g. only as data gatherers; or can they help to identify data, etc.).

Data gatherers ☐

Species identification / site grading

Co-researchers helping with scientific analysis	

Co-authors helping to report and publish findings

As educators using the resources for teaching but not contributing scientific data

Involved in awareness raising

Involved in advocacy initiatives	

Programme co-designers

Programme co-managers	

Other

Other

[illegible]

G2. Have you evaluated the experience of citizen scientists participation in the programme?

Is there any evaluation documentation of participation of citizen scientists within your programme?

Yes ☐

No

[illegible]

G3. If yes, please provide details and a reference if available.

Provide a short description of where the evaluation can be accessed and a summary of few of the key findings.

G4. Do you have any monitoring or evaluation data on impacts and changes in citizen science attitudes, values and behaviour related to participation in your programme?

We would like to know about any changes in values, beliefs, behaviour or attitudes that have happened because of participation in your project. Please only include researched and documented changes.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	476	477	478	479	480	481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500	501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521	522	523	52



H1. How do you measure success within your project?

X number of participants	

X number of contributions to your database	

% Coverage of a geographical area	
0	
10	
20	
30	
40	
50	
60	
70	
80	
90	
100	

X number of species documented

Successful resource / species related advocacy (e.g. zone demarcation / initiation of preservation policies) ☐

Other 

Other

[illegible]

The quality of the 'product' is most important

The quality of the data is most important

The quality of the process of data collection is most important

The quality of participation and public engagement is most important

A combination of the above is important (please clarify)

This question is in preparation of a question asking you to rank your success in different outcomes coming next.

Outcome 1								

Outcome 2								

Outcome 3									

[illegible]

Outcome 5								

[illegible]



H4. How would you rate the success of your project in terms of the INTENDED project outcomes?

Please only rate your success in terms of your previously stated intended outcomes. The next question deals with unintended outcomes.

	Unsuccessful	Partially successful	Successful	Meets intended outcome 100%	Exceeded our expectations
Outcome 1	☐	☐	☐	☐	☐
Outcome 2	☐	☐	☐	☐	☐
Outcome 3	☐	☐	☐	☐	☐
Outcome 4	☐	☐	☐	☐	☐
Outcome 5	☐	☐	☐	☐	☐
Outcome 6	☐	☐	☐	☐	☐

H5. Please list any unintended outcomes of your project that have been successful.

This section is for sharing any successful outcomes that you did not initially intend to achieve related to your project (for example, skills development, local area advocacy, career development, etc.

Outcome 1 (unintended)	☐	☐	☐	☐	☐	☐	☐	☐	☐
Outcome 2 (unintended)	☐	☐	☐	☐	☐	☐	☐	☐	☐
Outcome 3 (unintended)	☐	☐	☐	☐	☐	☐	☐	☐	☐
Outcome 4 (unintended)	☐	☐	☐	☐	☐	☐	☐	☐	☐
Outcome 5 (unintended)	☐	☐	☐	☐	☐	☐	☐	☐	☐
Outcome 6 (unintended)	☐	☐	☐	☐	☐	☐	☐	☐	☐

H6. Any metrics that are being captured to monitor the success of the project?

Yes ☐

No ☐

H7. Are these publicly available?

Yes ☐

No ☐



H8. Please provide details if available.

Please provide either a link to public access points or details of internal metrics if possible.

Section I: Project Recommendations and Lessons Learnt

In this section of the survey, we would like you to share any significant insights and lessons learnt through your project that might have relevance to other citizen science projects.

I1. Please provide any details of any significant findings from your project implementation experiences.

I2. Please provide details of any lessons learnt and recommendations from your project implementation experiences.

Section J: Barriers and Challenges

In this section of the survey, we hope to better understand the challenges and barriers to implementation faced by your project.

J1. Do any of the following describe barriers to successful implementation of your project? Please select all those that are relevant and provide a brief explanation for each.

This question relates to issues and challenges stopping or negatively affecting the implementation of your project.

Scientific capacity ☐

Project management capacity ☐

Number or skill of project staff ☐

Availability of funding ☐

Technological limitations ☐

Citizen scientist engagement and participation ☐



Citizen scientist skills level ☐

Lack of suitable or sufficient support resources for citizen scientists ☐

Quality of data collected ☐

Synthesis of data from multiple sources ☐

Other 1 (please specify) ☐

Other 2 (please specify) ☐

Other 3 (please specify) ☐

Section K: Project Documentation

This section of the survey aims to record any project documentation and resources that may be relevant to future research on citizen science.

K1. Please select all documentation options that describe how work from your project is being recorded and / or documented.

Internal reports ☐

Funder reports (not publicly available) ☐

Funder reports (publicly available) ☐

Project reports posted publicly (e.g. on project website) ☐

Research reports (not publicly available) ☐

Research reports (publicly available) ☐

Journal articles ☐

Theses ☐

K2. Please provide a list of any publicly available project documentation including journal articles and publicly available reports (we would appreciate your including any web URLs or access details where possible).

Journal publication

Journal publication

Journal publication

Journal publication

Journal publication

Project report

Project report

Project report



Project report

Project report

Other

Other

Other

Other

Other

Thank you for taking the time to share your project information with me.

Should you wish to contact me, follow up on any areas of information or amend your information, please feel free to contact me on:

priya@ecoskills.co.za

073 865-9985

P.O. Box 379, Grahamstown, 6140

APPENDIX 5: LITERATURE REVIEW - ANALYTICAL TOOL

EPISTEMIC FEATURES	MATTERS OF FACT	MATTERS OF CONCERN
EPISTEMIC PURPOSE	CLEARLY BOUNDED OBJECTS Object produced has clear boundaries - Well-defined essence; - Well-recognised properties - Defined in terms of strict laws of causality, efficacy, profitability & truth	NOT CLEARLY BOUNDED ... RATHER ENTANGLED - No clear boundaries - No well-defined essences - No separation between an object and its environment or context - Entangled within rhizomes, networks, etc.
EPISTEMIC SUBJECTS - epistemic organisations & institutions	INVISIBLE KNOWERS The 'knowers' of facts become invisible once the object is 'finished' / definition is established. - Scientific, technical, & industrial activity resulting in how an object becomes known remain out of sight.	KNOWERS & PROCESSES OF KNOWING REMAIN VISIBLE Knowers and their attendant conflicts, complications, controversies, instruments, workshops, laboratories, factories, etc. remain visible.
EPISTEMIC OBJECTS Psychological tools (mediate new forms and sequences of social behaviour) - re-create and re-order structure of learning; Object-relation regimes - how subjects approach objects of knowledge in research	OUTSOURCED IMPACTS & CONSEQUENCES Impacts & consequences are out-sourced to a 'different universe'. The factual object is construed as 'risk-free'. The 'other universe' is more generally and loosely defined in terms of "social factors", "political dimensions", "irrational aspects", etc. ...Risk is allocated here, in these aspects.	MATTERS OF CONCERN HAVE NO CLEAR IMPACT OF THEIR OWN - Defined relationally, and in terms of their numerous connections, tentacles & networks. - Defined out of the same universe within which they are enacted - Their consequences remain attendant in their definitions
EPISTEMIC RELATIONSHIPS	DEFY RETROACTIVE DEFINITION Risks arising from establishment of factual status of an object, after such definition occurs <i>never impact initial definition of the object</i> - including its boundaries & essence. Cataclysmic consequences have no retroactive effects on an objects definition or associated responsibilities.	UNDENIABLY IMPLICATED IN THIER CONSEQUENCES - Matters of concern are undeniably implicated in the consequences they may trigger at any point in time. - Unexpected consequences are, paradoxically, 'expected' by everyone. - Knowers accept responsibility for these consequences - Matters of concern produce iterative reflexive learning processes from such consequences.
	LOGICS OF NON-EXISTENCE	SOCIOLOGY OF ABSENCES
EPISTEMIC PRACTICES & PROCESSES	THE MONOCULTURE OF KNOWLEDGE & RIGOUR OF KNOWLEDGE Most powerful mode of non-existence Two key features: 1. Turns <i>modern science</i> into sole criteria of truth (natural) 2. Turns <i>'high culture'</i> into sole criteria of aesthetic quality (social) Each claim to be exclusive canons of production of knowledge or artistic creation. <i>Non-existence</i> is produced through: 1. Ignorance 2. Lack of culture	THE ECOLOGY OF KNOWLEDGES - Identification of other knowledges that operate credibly - Identification of other criteria of rigour (contextual credibility) - Contextual credibility is seen as sufficient legitimacy to enable participation in epistemological debates with other knowledges, including scientific knowledges - Underpinned by the principle of incompleteness of all knowledges, which enables the possibility of dialogue and debate among different knowledges - A relational move to re-establish relations between scientific knowledge and other knowledges, and among and between other knowledges
EPISTEMIC OUTCOMES	MONOCULTURE OF LINEAR TIME [Wig history] History has a unique and well known meaning - one which follows the western historical trajectory. <i>PROGRESS / MODERNISATION / DEVELOPMENT / GLOBALISATION</i> Time is led by those 'core' countries & cultures of the world and their dominant knowledges, institutions, and forms of sociality. This narration obscures simultaneity. <i>Non-existence</i> is produced through describing as backwards (pre-modern / undeveloped, etc.), whatever is asymmetrical to what is framed as forward.	THE ECOLOGY OF TEMPORALITIES - Articulates the constellation of temporalities which are activated differently in different contexts, creating an overlapping and interconnected diversity of temporalities - Makes visible and legitimate, constellations of times
	MONOCULTURE OF NATURALISATION OF DIFFERENCES (Logic of social classification) - Distributes populations according to categories that naturalise hierarchies - The relation of dominance is the consequence, rather than cause, of this hierarchy (and may be framed as an obligation of the superior) <i>Non-existence</i> is produced as a form of inferiority - insuperable inferiority because natural. The inferior cannot be a credible alternative to the superior because of this.	THE ECOLOGY OF RECOGNITIONS - Promotes recognition of equal differences - Works to make visible and critique moves to collapse difference and inequality, and the hierarchical arrangements which enable assertion of who is equal or different under a reformulated logic of naturalising differences

ANALYTICAL FRAMEWORK: INTERNATIONAL PEER-REVIEWED LITERATURE

	THE MONOCULTURE OF THE UNIVERSAL AND THE GLOBAL (The logic of dominant scale) - Dominant scale renders all others irrelevant - In western modernity, the dominant scale appears in two forms: 1. The universal - the scale of entities or realities that prevail regardless of specific contexts. They therefore dominate the particular or vernacular. 2. The global - privileges entities or realities that widen their scope to the whole globe, thereby designating rival entities as local. Non-existence is produced under the form of the particular and the local. Particular and local scales are hereby rendered incapable of being credible alternatives to the global or universal.	THE ECOLOGY OF TRANS-SCALES - Development of cartographic imagination aimed at a) recognising what each scale reveals and offers; and b) noticing and articulating what it conceals - Promotes and works to create cognitive maps that enable and operate simultaneously with different scales (local/global articulations) - Explores opportunities for counter-hegemonic globalization
	THE MONOCULTURE OF THE CRITERIA OF CAPITALIST PRODUCTIVITY (the logic of productivity) - Privileges growth and market forces - Applies both to nature and human labour - Transforms labour into a global resource, while simultaneously preventing the emergence of a global labour market Non-existence is produced as non-productiveness. As applied to nature as sterility, and applied to labour as ‘discardable populations, laziness, professional disqualification, lack of skills	THE ECOLOGY OF PRODUCTIVITIES - Directly confronts the paradigm of development and infinite economic growth (especially as it manifests in the sustenance and distribution of global capitalism) - Deliberately recuperates and valorises alternative systems and forms of production

Special Section: Moving from Citizen to Civic Science to Address Wicked Conservation Problems

Mapping epistemic cultures and learning potential of participants in citizen science projects

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Abstract: *The ever-widening scope and range of global change and interconnected systemic risks arising from people-environment relationships (social-ecological risks) appears to be increasing concern among, and involvement of, citizens in an increasingly diversified number of citizen science projects responding to these risks. We examined the relationship between epistemic cultures in citizen science projects and learning potential related to matters of concern. We then developed a typology of purposes and a citizen science epistemic-cultures heuristic and mapped 56 projects in southern Africa using this framework. The purpose typology represents the range of knowledge-production purposes, ranging from laboratory science to social learning, whereas the epistemic-cultures typology is a relational representation of scientist and citizen participation and their approach to knowledge production. Results showed an iterative relationship between matters of fact and matters of concern across the projects; the nexus of citizens' engagement in knowledge-production activities varied. The knowledge-production purposes informed and shaped the epistemic cultures of all the sampled citizen science projects, which in turn influenced the potential for learning within each project. Through a historical review of 3 phases in a long-term river health-monitoring project, we found that it is possible to evolve the learning curve of citizen science projects. This evolution involved the development of scientific water monitoring tools, the parallel development of pedagogic practices supporting monitoring activities, and situated engagement around matters of concern within social activism leading to learning-led change. We conclude that such evolutionary processes serve to increase potential for learning and are necessary if citizen science is to contribute to wider restructuring of the epistemic culture of science under conditions of expanding social-ecological risk.*

Keywords: environmental education, learning, learning curve, social-ecological risk

El Mapeo Epistémico de Culturas y el Potencial de Aprendizaje de los Participantes en los Proyectos de Ciencia Ciudadana

Resumen: *El siempre creciente enfoque y la extensión del cambio global y los riesgos sistémicos interconectados que surgen de las relaciones gente-ambiente (riesgos socio-ecológicos), parece incrementar la preocupación entre, y la participación de, los ciudadanos en un número cada vez más diverso de proyectos de ciencia ciudadana que responden a estos riesgos. Examinamos la relación entre las culturas epistémicas en los proyectos de ciencia ciudadana y el potencial de aprendizaje relacionado con temas de importancia. Después desarrollamos una tipología de propósitos y una de ciencia ciudadana heurística y de culturas epistémicas y mapeamos 56 proyectos en el sur de África usando este marco de trabajo. La tipología de propósitos representa la extensión de los propósitos de producción de conocimiento, que van desde ciencia de laboratorio a aprendizaje social, mientras que la tipología de culturas epistémicas es una representación relacional de la participación científica y ciudadana y su acercamiento a la producción de conocimiento. Los resultados mostraron una relación iterativa entre los temas de hechos y los temas de importancia en todos los proyectos; el nexo del compromiso de los ciudadanos en las actividades de producción de conocimiento fue variado. Los propósitos de producción de conocimiento informaron y formaron las culturas epistémicas de todos los proyectos muestreados de ciencia ciudadana, lo que a la vez influyó en el potencial de aprendizaje*

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Chapter 5

Transforming epistemic cultures in ESE with citizen and civic sciences as means for reframing participation in the commons

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Abstract

There are increasing calls among environmental educators for critically engaged citizens who are able to respond to wicked problems and ‘matters of concern’ now commonplace within the Anthropocene. However, the current system of validated knowledge production works to exclude citizens from knowledge work, thereby distancing citizens from the coherence, logic and systematic process of knowledge production, leaving them in relatively weak positions to engage with knowledge products critically. In this chapter, and drawing on a critical review of over 60 citizen science projects, I argue for a strengthening of epistemic cultures in ESE through citizen science practices that foreground the creation of situated and embodied knowledge. This, I argue, offers expansive, viable and robust alternatives to taken-for-granted institutional knowledge production practices. I invoke the work of Knorr Cetina to propose alternative, futures oriented epistemic cultures which integrate ‘ecologies of knowledge’ that are more appropriately suited to engaging citizens in critical knowledge production activities. I draw on the emergent relationships between knowledge production and critical engagement with situated environmental challenges to illustrate how these alternative frameworks might contribute to the reclamation of scientific inquiry as an act performed within the commons, towards the well-being and communal reframing of the commons.

Keywords: citizen science; epistemic cultures, ecologies of knowledges

Introduction

In this chapter, I begin by troubling the current institutionalisation of scientific activity as inadequate to meeting the social-ecological challenges arising within

**Research into Alignment, Scaling and Resourcing of
Citizen Based Water Quality Monitoring (CBWQM) to Realising
the DWS Integrated Water Quality Management Strategy**

Deliverable 3:

Initial Review of CBWQM Practice:

Insights for scaling, alignment and resourcing

Report to the
WATER RESEARCH COMMISSION

by

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Research into Alignment, Scaling and Resourcing of Citizen Based Water Quality Monitoring (CBWQM) to Realising the DWS Integrated Water Quality Management Strategy

Deliverable 4:

Understanding the potential for realising national and international policy commitments through CBWQM

**Report to the
WATER RESEARCH COMMISSION**

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1. Introduction and Aims

The need for securing the integrity of participatory democracy and empowered co-engagement are clearly a priority in contexts where social and ecological injustices and degradation continue to occur. This is true across South Africa, where we, as a society are working out the direction and just functioning of a relatively new democracy. In such a context citizen voices must be noticed and heard, including the voices of those affected by the social-ecological degradation, injustices and impacts of the time.

Community Based Water Quality Monitoring (CBWQM) is emerging as an important practice that helps to consolidate participatory democracy in South Africa, with much potential to enhance water quality management in the country, if well supported. But the practice has been identified as fragmented with a number of complex challenges, including structural and implementation challenges. In response, this study seeks to review the field of CBWQM practices in order to inform scaling, alignment and resourcing towards realizing the objectives of the Department of Water Affairs and Sanitation's *Integrated Water Quality Management Policy and Strategy*, which envisions an inclusive, integrated approach to WQM. Embedded in the field of practice are complex contradictions and difficulties that produce tensions, contradictions and discontinuities, but also substantial opportunities for change and co-learning.

The recent *Presidential Jobs Summit Framework Agreement* (2018) recognised the importance of activities such as Community Based Water Quality Monitoring (CBWQM) within a framework for job creation in the context of national water stewardship, indicating one of many potential pathways for scaling of this practice. Exploring and articulating, as well as establishing action learning routes along scaling and alignment pathways is one of the intentions of this project. Hence the need articulated by this project's objectives for expanding capacity for CBWQM in South Africa, as also identified in recent water quality monitoring policy in South Africa.

APPENDIX 10: CHAPTER 5 LITERATURE SOURCES

PAPER TITLE	TYPE	SOURCE	DATE
Australian Citizen Science Association (ACSA)	Website	https://citizenscience.org.au	2021
Barton, A. M. C. Citizen(s') Science: A Response to "The Future Of Citizen Science"..	Journal	<i>Democracy & Education</i>	2012
Bonney, R. Citizen Science: A Lab Tradition.	Magazine	<i>Living Bird</i>	1996
Bonney, R., Ballard, H., Jordan, R., McCallie, E., Phillips, T., Shirk, J., & Wilderman, C. C. Public Participation in Scientific Research: Defining the Field and Assessing Its Potential for Informal Science Education.	Report	<i>A CAISE Inquiry Group Report.</i>	2009
Braschler, B. Successfully Implementing a Citizen-Scientist Approach to Insect Monitoring in a Resource-Poor Country.	Journal	<i>BioScience</i>	2009
Cambridge Dictionary. Entry: Citizen Science.	Online dictionary	https://dictionary.cambridge.org/dictionary/english/dictionary.	2021
Cardamone, C., & Lobel, L. Using Citizen Science to Engage Introductory Students: From Streams to the Solar System.	Journal	<i>Journal of Microbiology & Biology Education</i>	2016
Citizen Science Association (CSA)	Website	https://citizenscience.org	2021
CitizenScienceAsia (CSAsia)	Facebook page	https://www.facebook.com/CitSciAsia/	2021
Citizen Science Theory and Practice (CSTP). Home Page: About This Journal.	Website	theoryandpractice.citizenscienceassociation.org	2021
Clark, F., & Illman, D. L. Dimensions of Civic Science: Introductory Essay.	Journal	<i>Science Communication</i>	2001
Cooper, C. B. Links and Distinctions Among Citizenship, Science, and Citizen Science. A Response to "The Future of Citizen Science.".	Journal	<i>Democracy and Education</i>	2012
Cooper, C. B., Dickinson, J., Phillips, T., & Bonney, R. (2007). Citizen Science as a Tool for Conservation in Residential Ecosystems.	Journal	<i>Ecology and Society</i>	2007

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Devictor, V., Whittaker, R. J., & Beltrame, C. Beyond Scarcity: Citizen Science Programmes as Useful Tools for Conservation Biogeography.	Journal	<i>Diversity and Distributions</i>	2010
Dickinson, J.L., Shirk, J., Bonter, D., Bonney, R., Crain, R.L., Martin, J., Phillips, T. & Purcell, K. The Current State of Citizen Science as a Tool for Ecological Research and Public Engagement.	Journaal	<i>Frontiers in Ecology and the Environment</i>	2012
Dickinson, J. L., Zuckerberg, B., & Bonter, D. N. Citizen Science as an Ecological Research Tool: Challenges and Benefits.	Journal	<i>Annual Review of Ecology, Evolution, and Systematics</i>	2010
Dillon, J., Stevenson, R. B., & Wals, A. E. Introduction to the Special Section Moving from Citizen to Civic Science to Address Wicked Conservation Problems. Corrected by erratum 12844.	Journal	<i>Conservation Biology</i>	2016
Edwards, R. The 'Citizens' in Citizen Science Projects: Educational and Conceptual Issues.	Journal	<i>International Journal of Science Education</i>	2014
Eitzel, M.V., Cappadonna, J.L., Santos-Lang, C., Duerr, R.E., Virapongse, A., West, S.E., Kyba, C.C.M., Bowser, A., Cooper, C.B., Sforzi, A. & Metcalfe, A.N. Citizen Science Terminology Matters: Exploring Key Terms.	Journal	<i>Citizen Science: Theory and Practice</i>	2017
Ellwood, E. R., Crimmins, T. M., & Miller-Rushing, A. J. Citizen Science and Conservation: Recommendations for a Rapidly Moving Field.	Journal	<i>Biological Conservation</i>	2017
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Heigl, F., Kieslinger, B., Paul, K. T., Uhlik, J., & Dörler, D. Opinion: Toward an International Definition of Citizen Science.	Proceedings	<i>Proceedings of the National Academy of Sciences</i> , 116(17), pp.8089-8092.	2019
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Hochachka, W. M., Fink, D., Hutchinson, R. A., Sheldon, D., Wong, W. K., & Kelling, S. Data-Intensive Science Applied to Broad-Scale Citizen Science.	Journal	<i>Trends in Ecology & Evolution</i>	2012
Irwin, A. <i>Citizen Science: A Study of People, Expertise and Sustainable Development.</i>	Book	Psychology Press.	1995
Jordan, R., Gray, S., Sorensen, A., Newman, G., Mellor, D., Newman, G., Hmelo-Silver, C., LaDeau, S., Biehler, D. & Crall, A. Studying Citizen Science Through Adaptive Management and Learning Feedbacks as Mechanisms for Improving Conservation.	Journal	<i>Conservation Biology</i>	2016
Kridelbaugh, D. M. The Use of Online Citizen-Science Projects to Provide Experiential Learning Opportunities for Nonmajor Science Students.	Journal	<i>Journal of Microbiology & Biology Education</i>	2016
Lewandowski, E. J., & Oberhauser, K. S. Butterfly Citizen Scientists in the United States Increase Their Engagement in Conservation.	Journal	<i>Biological Conservation</i>	2017

PAPER TITLE	TYPE	SOURCE	DATE
Loss, S. R., Loss, S. S., Will, T., & Marra, P. P. Linking Place-Based Citizen Science with Large-Scale Conservation Research: A Case Study of Bird-Building Collisions and the Role of Professional Scientists.	Journal	<i>Biological Conservation</i>	2015
Macmillan Dictionary. <i>Citizen Science</i> . Macmillan Education Limited.	Online dictionary	https://www.macmillandictionary.com .	2021
Marrian-Webster Online Dictionary	Online dictionary	Null entry	Null
McKenney, E., Flythe, T., Millis, C., Stalls, J., Urban, J. M., Dunn, R. R., & Stevens, J. L. Symbiosis in the Soil: Citizen Microbiology in Middle and High School Classrooms.	Journal	<i>Journal of Microbiology & Biology Education</i>	2016
McKinley, D.C., Miller-Rushing, A.J., Ballard, H.L., Bonney, R., Brown, H., Cook-Patton, S.C., Evans, D.M., French, R.A., Parrish, J.K., Phillips, T.B. & Ryan, S.F. Citizen Science Can Improve Conservation Science, Natural Resource Management, and Environmental Protection.	Journal	<i>Biological Conservation</i>	2017
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Shah, H. R., & Martinez, L. R. Current Approaches in Implementing Citizen Science in the Classroom.	Journal	<i>Journal of Microbiology & Biology Education</i>	2016
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Strasser, B., Baudry, J., Mahr, D., Sanchez, G., & Tancoigne, E. "Citizen Science"? Rethinking Science and Public Participation.	Journal	<i>Science & Technology Studies</i>	2019

PAPER TITLE	TYPE	SOURCE	DATE
Sullivan, B.L., Phillips, T., Dayer, A.A., Wood, C.L., Farnsworth, A., Iliff, M.J., Davies, I.J., Wiggins, A., Fink, D., Hochachka, W.M. & Rodewald, A.D. Using Open Access Observational Data for Conservation Action: A Case Study for Birds.	Journal	<i>Biological Conservation</i>	2017
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United Nations Environment Program (UNEP). <i>Year Book 2014 Emerging Issues Update.</i>	Year Book	UNEP publication	2014
Weinstein, M. Schools/Citizen Science. A Response to " The Future of Citizen Science".	Journal	<i>Democracy and Education</i>	2012
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Yoho, R. A., & Vanmali, B. H. Controversy in Biology Classrooms—Citizen Science Approaches to Evolution and Applications to Climate Change Discussions.	Journal	<i>Journal of Microbiology & Biology Education</i>	2016

Draft paper:

(Re)membering, (Re)framing, & (Re)constituting Rigour

By Priya Vallabh

1. (Re)membering, (Re)framing, and (Re)constituting Rigour

This chapter is an invitation to reconsider what is meant by rigour. The meaning I choose is that rigour is a way of supporting integrity, and that systems of rigour are what we might use to guide us into deeper levels of integrity within our knowledge work.

Rigour-as-Integrity

I propose that the definition 'rigour-as-integrity' is a good one for guiding commoning (see 1.5.4.) towards whichever common goods we choose to establish. It takes us away from over-reliance on analytical rigour, towards a complexity of integrity that is neither scientific in and of itself, nor dismissing of the epistemic integrity of science.

Rigour-as-integrity invites us to consider where integrity is missing, and which forms of rigour might be leveraged to breach such gaps, Abysses, Divides, regardless of the form or system of knowledge we leverage in response to our individual and collective struggles. Rigour-as-integrity calls to us to think, and rethink, and to feel, and to experience in deeper ways - in ways that acknowledge our own realities, but which also consider the ways in which our realities interact and react and reflect on the realities of diverse others. Rigour-as-integrity calls us beyond the established systems, and the benefits we have learnt to mobilise within those systems, towards challenging those same systems, and onward, towards the generation of other (re)imagined systems and stories and ways of knowing which enrich the ways we might live together, common together, and journey towards as yet only partially visible futures together.

Rigour-as-integrity calls on us to expand our definitions of 'together', to question who and what has been left out, why they have been excluded, what the costs of these

exclusions are, and importantly, how we are benefited by their exclusions. Rigour-as-integrity makes noisy and visible our Earth, our brethren who live in the bodies of other species, our peoples, our ancestors and our future generations who might have been excluded and forgotten, those others who have been produced as nonexistent, or only partially existent, or expedient ... those aspects of ourselves that we have had no choice but to send to the hinterlands to keep company with those countless excluded others.

Rigour-as-integrity takes us beyond the management of data, and the analytical systems of data, without diminishing the value of that aspect of knowledge work. Instead, it calls on us to remember that analytical rigour is but one aspect of what supports us to generate common knowledges with integrity - important yes, but fundamentally incomplete without the other aspects of knowledge work that bring us into integrous relations with and within our common world.

My discussion here is a simple one, intended to resource common and collective knowledge work in ways that contributes to the building of sanctuaries (after Haraway) suitable for all. It is propositional and emergent from the struggles of writing what I hope is a post-abysally expansive thesis, within a hegemonic knowledge structure (see 4.3 to 4.7 for details of this process). Santos notes three steps involved in building common knowledge, which I suggest require rigour-as-integrity, including:

the identification of knowledges [1], ... the procedures for relating them to each other [2], and ... the nature and assessment of real-world interventions made possible by them [3] (Santos, 2007:18).

In response, I discuss five interrelated forms of rigour as commoning. These forms of rigour have emerged through my engagement with a range of theories leveraged in this study, as well as my attempts to apply their arguments into my research practice. What is presented emerges from a critical and reflexive reframing and synthesis of the work of many scholars, including my own. Where possible, I have indicated the work of key authors, whose work is significantly foundational to my arguments below.

The five forms of rigour I propose are:

- Rigour as engaging with and making visible, ontological politics;
- Rigour as reclaiming onto-epistemic imaginaries;
- Rigour as (re)membering and bridging Abysses and Great Divides, including three aspects:
 - Rigour as engaging sociologies of absences;
 - Rigour as internal coherence; and
 - Rigour as external coherence;
- Rigour as enhancing conceptual integrity; and
- Rigour as analytical integrity.

Each of these forms of rigour were used to increase the integrity of this particular study, and required (re)articulation as the thesis unfolded.

2. A Tango Towards Rigorous Ontological Politics

The first form of rigour-as-integrity that I struggled with was an engagement with ontological politics within research methodology, and the subsequent translation of methodology into research practice (see 4.4). Engaging with ontological politics is about recognising the plurality of ontologies, and that research always concerns choices about the realities we enact, and those we either set aside or actively produce as nonexistent.

A of methodological offerings have informed my understanding and subsequent framing of this form of rigour, including, Mol's framing of ontological politics (1999), Law's immanent critique of scientific processes of legitimising knowledge (2004), Alcoff's challenge of speaking for others in research (1991), Andreotti et al.'s¹ educational questions highlighting knowledge politics (2018), Amsler's educational propositions for radical democracy (2015); Waller's work on indigenous research ethics (2010), Lather's work on rethinking ontology (2016) and validity (1986), Smith's offering on decolonising methodologies (2013[1999]), Jank's processes of reading with and against texts (1997), and many others. Each provide substantive openings for robust engagements with ontological politics.

Rigour as engaging with and making visible, ontological politics is concerned with:

- a) Making visible the always present, often undeclared ontological politics enacted within the forms of knowledge being produced;
- b) Challenging and reconstituting research approaches so that they engage a stronger integrity in response to ontological injustices, and responsively realign epistemic enactments;
- c) Making visible, the research decisions and choices which have been leveraged in response to this form of rigour; and finally,
- d) Making visible the weakness, gaps and as yet unresolved ontological politics within a research study (recognising that these are as important to this form of rigour as articulating what is present and has been addressed).
- e) Mol (1999:79) offers a simple starting point, suggesting that we begin by asking:
 - *Where are the options?*
 - *What is at stake?*
 - *Are there really options?*
 - *How should we choose?*

What counts as a legitimate account of ontological politics, and how it influences epistemic decisions in research will need to remain emergent and reflexive, recognising that each research approach brings with it its own disciplinary, contextual and political practices. Accounting for ontological politics is therefore, primarily, a reflexive act.

The approach adopted in this study was enacted as an ontological Tango which evoked the work of a range of researchers and worked between hegemonic approaches and post-abyssal expansions of research approaches. These two approaches to research were not harmonious, nor were they intended to be. The conflicts between these two research cultures also aptly reflected similar struggles within the diverse practices of the citizen sciences, as reflected in the case studies presented in Chapter 7. In this study, I focused on the ontological politics of generating ecologies of knowledges within the legitimising structures of the sciences, as well as those between building public knowledge as compared to commoning as processes for generating common goods.

1 Andreotti, V., Stein, S., Sutherland, A., Pashby, K.L., Susa, R. and Amsler, S.

3. Rigour as (Re)claiming Onto-Epistemic Imaginaries

Rigour as (re)claiming onto-epistemic imaginaries (after Verran, 1998), is about *enabling* ontological generativity (see 4.5). It is about strengthening the integrity with which we leverage particular sets of ontologies and their associated politics, and recognising that these choices are always made, and might therefore also be (re)made. It takes as its starting point, recognition that “[o]ntologies and epistemologies of other worlds show other ways of experimenting and knowing the global”, allowing us to overcome, interconnect, un-know, and (re)stor(y) existing epistemologies (Querejazu, 2016:4). It is a preliminary step to the facilitation of coherent cross-epistemological conversations.

Rigour as (re)claiming onto-epistemic imaginaries is concerned with:

- a) Acknowledgement that all the social structures, relations, objects that we take as established and normal, themselves arose from particular onto-epistemic imaginaries which were then inscribed into our collective world. And that these imaginaries were grounded within, arose from, and perpetuate particular realities;
- b) Recognition that different imaginaries might, therefore, be leveraged in the creation of alternative futures, and that other ontologies provide fertile opportunities for contributing to the generation of more coherent and robust onto-epistemic imaginaries;
- c) Generation of at least partially shared onto-epistemic imaginaries as acts of commoning; and
- d) Reflection on the ontological politics which are reconfigured, and come to dominate new onto-epistemic imaginaries as they are inscribed within (re)imagined social structures, relations and objects, etc.

A simple starting point, mimicking Mol's suggestions (1999), might be to ask:

- Which imaginaries inform our version of reality?
- How are they being inscribed and enacted?
- What are the options for alternatives?
- What is at stake?
- Are there really options?
- How should we choose?

Again, what count as legitimate onto-epistemic imaginaries, and how they might influence epistemic decisions will need to remain emergent and reflexive to contexts of practice. Generating onto-epistemic imaginaries are therefore a reflexive, and hopefully collective, act. In this study, onto-epistemic imaginaries were leveraged as a way to enlarge both perspectives on knowledge-legitimacy, as well as (re)imagine epistemic structures and arrangements which might more strongly enable epistemic activity as commoning, towards the generation of common goods.

4. (Re)membering and Bridging Abyssal Lines and Great Divides

[I]n fact, it is only modern western science that has systematically adhered to its claims to be the universal basis of knowledge. As a result, an alternative science today is often seen as another paradigm or gestalt that can challenge the current dominance of science and offer a parallel claim of universalism. Such terms of discourse create a captive text. It sets up a Kuhnian frame where only one system of knowledge can survive at a time and where the idea of a pluralistic regime of proliferation is seen as a cognitive weakness. Such a model of knowledge creates what has been called 'a monoculture of the mind' and it is precisely this which the discourse of alternative sciences seeks to break (Visvanathan, 2006:164).

Visvanathan (2006) also notes that adopting a pluralistic system of 'alternative knowledges' requires an examination of the relation of science to other forms of knowledge. This in turn calls for considering and developing a robust understanding of the varying bases of legitimation operating within alternatives, and engaging in the careful work of reconciling these diverse legitimacies while resisting the need to subsume or dismiss them based on scientific systems of legitimation. To legitimate through science is to acknowledge only the legitimacy of what is visible within science, and to dismiss anything which falls outside of the onto-epistemic view of what science (re)presents.

On the other hand, the unquestioning acceptance of any and all knowledge forms within an ecology of knowledges brings with it a danger of relativism which precludes the possibility for commoning as ways of generating coherent

and just commons. I suggest that the task here is not to identify the means by which to evaluate the single most superior form of knowing, and to use this form of knowing to legitimate all others. Rather, we might recognise that different forms of knowing are derived from diverse forms of onto-epistemic coherence and logics. Understanding these logics provide a basis for inter-knowledge coherence which is not possible without first perceiving what makes a knowledge coherent.

Rigour as (re)membering and bridging Abyssal Lines and Great Divides is about establishing and articulating systems of internal and external coherence. It is about making visible how legitimacy is constituted within and between knowledges, in light of the ontological politics at play (both internally and externally). This form of integrity takes three forms:

- Rigour as engaging sociologies of absences;
- Rigour as internal epistemological coherence; and
- Rigour as external coherence, between diverse knowledges.

While Santos (2016, 2004) Latour (2004), Visvanathan (2006), and a range of other decolonial and counter-hegemonic scholars have dedicated much time to considering how to best determine epistemic legitimacy between knowledge types, less work has been done considering internal epistemological coherence within distinct knowledges. There has been robust critique challenging the use of western scientific systems of legitimation as the mechanism by which all other forms of knowledges are evaluated, and this is certainly a key concern that must be addressed. As argued in Chapter 2, knowledges have often substantively different internal logics, which just as often arise from markedly diverse ontologies. As Santos points out,

whatever the extent to which science is resorted to, counter-hegemonic practices are mainly practices of nonscientific knowledges, practical, often tacit knowledges that must be made credible to render such practices credible in turn (2004:13).

This leaves somewhat of a gap in rigour as regards systems of internal epistemological rigour which are a prerequisite for rigour as external coherence, and which better equips epistemic subjects to minimise potential for outright relativism within common knowledge-building. I engage

with this gap in 4.2 briefly, before providing a brief orientation to rigour as external coherence.

4.1 Rigour as Engaging Sociologies of Absences

The arguments for rigour as engaging sociologies of absences has been carefully articulated by Santos (2016a, 2016b, 2009, 2007, 2006, 2004; also see 2.9), and form the primary basis for this conception of rigour. Here, I simply wish to lift to visibility, the need for this form of rigour as commoning, in response to social-ecological risks, and towards generating common goods.

Rigour as engaging sociologies of absences is about actively analysing for produced nonexistence, and bringing back into visibility both the systems which result in produced nonexistence of some epistemologies, while elevating the contributions of others, as well as those specific knowledges which are marginalised or rendered invisible within particular epistemic contexts. It is about facilitating the integrous inclusion of ways of knowing the world in both our processes of knowledge-making, and also our accounts of knowledge production. As demonstrated in the case studies (Chapter 7), diverse forms of knowledge are often already present and contribute substantively to the production of common knowledges, and yet remain invisible and produced as nonexistent through the legitimacy-making processes of hegemonic scientific practices. This form of rigour seeks to actively address epistemic injustices.

Rigour as engaging sociologies of absences is therefore, concerned with:

- a) Identifying already contributing knowledges, which are being produced as nonexistent;
- b) Identifying potential knowledge contributions from currently excluded knowledges;
- c) Recognising the bases of legitimacy upon which some knowledges are included, others excluded; and
- d) Engaging with, challenging and dismantling or realigning systems which enable produced nonexistence; and making visible and present a range of existent or potentially useful knowledges.

A simple starting point might be to ask:

- Which forms of knowledges do diverse epistemic subjects contribute?
- How are they being inscribed and enacted?
- How are they being recognised within legitimated (and official) accounts of knowledge production?
- How are they being recognised within social practices?
- Who is moderating, managing and selecting knowledge representations?

4.2. Rigour as Internal Epistemological Coherence

The next step in engaging ecologies of knowledges is the articulation of internal systems of epistemological coherence, so that those engaging a particular knowledge form are able to recognise what the basis of coherence is for such a knowledge. I do not mean that we need lists of criteria for each knowledge form *per se*. Rather, I mean that the basis for legitimacy - the basis for internal coherence must be made transparent, both as a way to articulate and reclaim the legitimacy of a way of knowing, as well as a way to facilitate engagement between knowledges. As Santos notes,

The point is not to ascribe equal validity to all kinds of knowledge, but rather to allow for a pragmatic discussion of alternative criteria of validity, which does not straightaway disqualify whatever does not fit the epistemological canon of modern science (2004:19).

As demonstrated in the case studies in Chapter 7, other forms of knowledge are primarily dealt with through hegemonic sorting and clearing, through filters of scientific warranting (at least in the context of the citizen sciences). The citizen scientists in each of these cases, recognised that they held legitimate knowledges which contributed meaningfully to collective tasks, but the knowledges remained mostly unnamed and were rendered epistemically irrelevant through scientific filtering and sorting. These knowledges were mostly invisible for these reasons - they were unnamed and the bases of their epistemic legitimacies were unarticulated, in spite of their demonstrably significant epistemological contributions. Mostly, citizen scientists failed to argue for their legitimacy because they were unable to describe their bases of

coherence in scientific terms, although they could describe the practices and contributions within context in detail.

Rigour as internal epistemological coherence is concerned with:

- a) Articulating the bases of legitimacy, and therefore coherence, *within* a particular knowledge form; and
- b) Working to unseat any tendency to use scientific systems of legitimacy to impose scientific coherence on another knowledge form. This second aspect is a reflexive task, recognising that setting aside the hegemony of science is not easy in light of its epistemological dominance.

So how do we go about articulating coherence in embodied knowledges, which are experienced as bodily sensations, changes, and internally-referenced states of being, compared to rationally-based knowledges, or relational knowledges which convene diverse forms of knowing into a unified knowledge form? A number of authors who have begun this work are mentioned in 7.1.3., although that list is by no means exhaustive. The Aboriginal and indigenous knowledges movements have also produced substantive contributions towards this need.

In beginning this work of articulating internal coherence, we might ask of each form of knowledge:

- What does 'knowing' in this knowledge form encompass?
- How do we compare one instance of knowing to another, in this form of knowledge?
- What makes this knowledge internally coherent?
- How is this form of knowledge related to context or experience?
- How do we or might we increase internal coherence?
- Is this form of knowledge self-referential, externally referential, or some combination of both?

Santos (2007:18) also provides some broader starting points, suggesting that we ask:

- From what perspective can different knowledges be identified?
- How can scientific knowledge be distinguished from non-scientific knowledge?
- How can we distinguish between various non-scientific knowledges?

- *How can we distinguish non-western knowledge from western knowledge?*
- *If there are various western knowledges and various non-western knowledges, how do we distinguish between them?, and*
- *What do hybrid knowledges, mixing western and non-western components look like?*

4.3. Rigour as External Coherence Between Knowledges

Once the bases of internal coherence have been established, we are better situated to distinguish useful and integrious mechanisms for external coherence between diverse knowledge forms. Santos points out that,

Ecology of knowledges does not imply acceptance of relativism. On the contrary, from the point of view of a pragmatics of social emancipation, relativism, as absence of criteria of value hierarchies among knowledges, is an untenable position, because it renders impossible any relation between knowledge and the meaning of social transformation (Santos, 2004:19).

Once again, Santos (2004), and Latour (2004) have provided robust consideration of how knowledges might be commiserated with each other. Both argue that the basis of legitimacy for inclusion in an ecology of knowledges should be its potential contribution for intervention into context (or intervention in response to social-ecological risk). Such contributions cannot be purely epistemological, perceived as a universal characteristic of a knowledge form because they must be able to contribute legitimately to resolving social-ecological challenges which they, by their own, might never pose (Santos, 2009). Therefore, both authors also argue for the importance of practice in such considerations (see 2.7 and 2.9 for their detailed arguments).

The priority given to practices brings about a fundamental change regarding the ways of knowing in presence. The superiority of a given way of knowing is no longer assessed by its level of institutionalization and professionalization, but rather by its pragmatic contribution to a given practice. One of the motors of epistemological fascism, which has characterized the relation of modern science

with other ways of knowing, is thereby deactivated (Santos, 2009:118).

This contextual practice-based process of legitimation therefore has the effect of turning 'all ways of knowing into experimental ways of knowing', (Santos, 2009:118). Latour's arguments for the generation of propositional knowledge produced through 'matters of concern', is pertinent here, because it holds all knowledge as propositional, and subject to challenge, refinement, and reconstitution, in light of new knowledges and knowledge-practices (2004). In resonance, Santos points out that,

[T]he ecology of knowledges favours context-dependent hierarchies, in light of the concrete outcomes intended or achieved by different knowledge practices. Concrete hierarchies emerge from the relative value of alternative real-world interventions. Complementarity of contradictions may exist between different types of intervention ... preference must be given to the form of knowledge that guarantees the greatest level of participation to the social groups involved in its design, execution, and control and in the benefits of the intervention (Santos, 2007:15).

Rigour as external coherence between knowledges is concerned with:

- a) Assessing the nature and dimensions of situated risks;
- b) Considering the potential for various, diverse knowledges for intervention into context, in response to risk;
- c) Working to make visible issues of epistemic injustice within knowledge practices;
- d) Working coherently within, between, and across knowledges, in ways which take account of established systems of produced nonexistence, and internal systems of epistemological coherence, to leverage knowledges (through their knowledge practices), in response to social-ecological risks; and
- e) Recognising and articulating legitimacy in terms of real-world interventions within open systems.

Santos (2007:18), once again, provides some starting points for convening diverse knowledges, suggesting that we begin by asking:

- *What types of relationships are possible between the different knowledges?*

- How can we distinguish between incommensurability, incompatibility, contradiction, and complementarity?
- Where does the will to translate² come from?
- Who are the translators?
- How should we choose translation partners and issues?
- How can we form shared decisions and distinguish them from imposed ones?
- How can we make sure that intercultural translation does not become the newest version of abyssal thinking, a soft version of imperialism and colonialism?

5. (Re)constituting Conceptual Rigour to Strengthen Integrity

Conceptual rigour is an already well-established practice within the western sciences. What I wish to argue is that conceptual rigour should be engaged within a system of rigour which has engaged ontological politics. Here, integrity, is about conceptual coherence. Conceptual rigour is constituted to achieve particular ends. It is value-laden and leverages a particular onto-epistemic imaginary towards a chosen epistemic destination. It is one form of inscribing ontological politics into a research context, and simultaneously arises from and is imposed on epistemic practice.

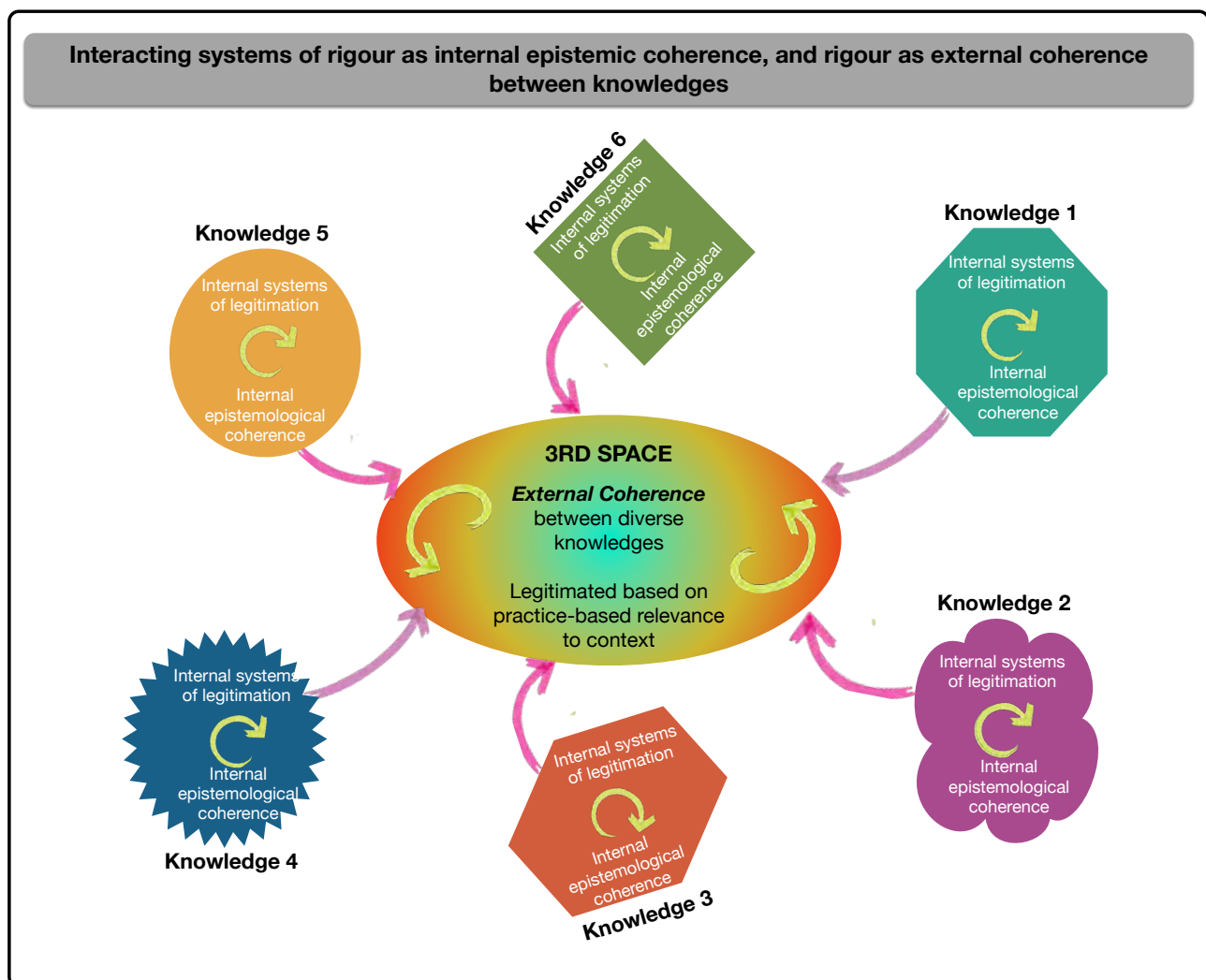


Figure 1: Interacting systems of rigour as internal epistemological coherence, and external coherence between knowledges

Rigour as enhancing conceptual integrity is primarily about making conceptual choices visible for the choices they are. It is about visibly acknowledging that conceptual choices are constituted to forward particular ontological politics,

² Translate, in this instance, is derived from Santos's arguments for inter-cultural translation between knowledges (2004; also see 2.11.4).

rather than viewing them as naturalised ways of thinking about and viewing social phenomena. For example, in this study, foregrounding an interest in the common good, arises from my own particular imaginaries for, and of, the world. While there is certainly resonance with the motivations of various groups of citizen scientists, and even professional scientists (re)presented through this work, the choice to leverage notions of the common good, rather than the public good, are imposed by me, in resonance with my disciplinary context of epistemic practices, and my propositions about responding to social-ecological risks.

My conceptual framework is used to (re)constitute a constellation of concepts which centre a specific epistemic politics - that of post-abyssal systems of knowledge production which generate common goods. The concept of the common good is ontologically charged and epistemically enacted through the other concepts it coheres with. It was neither objective, nor neutral, even as I attempted to work rigorously and substantively with the concept constellation which outlined the ontological politics I was leveraging through various epistemic practices in this thesis.

Rigour as enhancing conceptual integrity is therefore concerned with:

- a) Visibly claiming particular political ontologies in the form of concepts and concept constellations, in service to knowledge production activities, thereby making recognisable their value-laden natures and debunking perceptions of objectivity or neutrality; and
- b) Strengthening coherence between elements within a conceptual constellation of onto-epistemic imaginaries, so that they are onto-epistemically coherent with each other and the epistemic goals of an act of knowledge production.

To begin with, we might ask:

- Which ontological ground do I claim by leveraging a particular concept?
- What are the dominant concepts within my conceptual constellation?
- Are these concepts coherent with each other?
- Are these concepts coherent with my knowledge production goals?

- Have I made visible, the ontological politics I am forwarding?
- What are the epistemic and political implications of my conceptual choices?

6. (Re)membering Analytical Rigour as a Form of Integrity

Systems of analytical rigour have been well established within most disciplinary fields in the western sciences. They form the backbone of scientific legitimacy-making practices within most knowledge work. As argued above, analytical rigour often bears the bulk of the weight for evidencing rigour within research, to the detriment of other forms of integrity-as-rigour. Scientific protocols, as inscribed systems of analytical rigour, dominate research methodology practices, criteria for coherent research proposals, and as mediators of epistemic practices and processes - to the extent that they are sometimes substituted for analytical integrity itself.

Scientific protocols and systems of analytical rigour are primarily focused on presence - what is acceptable as a legitimate knowledge contribution, and by nature, exclude knowledge contributions which are perceived to fall outside of legitimacy criteria. This, in and of itself, is useful as a way to confine research focus and scope in meaningful ways. However, as Law (2004) argues, this simultaneously renders invisible, what has in fact, been produced as nonexistent. *Rigour as analytical integrity* is about both circumscribing epistemic activity in meaningful ways, as well as visibly acknowledging what has been produced as nonexistent, and why. It is this second aspect of rigour as analytical integrity I wish to foreground, because it is, once again, implicated in, and an enactment of ontological politics.

Rigour as analytical integrity is therefore concerned with:

- a) Circumscribing epistemic focus in meaningful ways, which are recognised for the ontological and epistemic choices they are;
- b) Making visible, what is being excluded or produced as nonexistent, or peripheral (including what has been 'cleaned out'), and why;
- c) Making visible which ground is claimed through such choices, and how they forward a particular ontological politics;

- d) Strengthening coherence between research instruments and practices as inscriptions and mediators of the other forms of *rigour-as-integrity* within epistemic practice; and
- e) Making visible the retrospective gaps, flaws, and incoherences within protocols as onto-epistemic inscriptions.

To begin with, we might ask:

- *Are my research protocols and systems of analysis coherent in terms of conceptual integrity?*
- *Which knowledge contributions were sought out?*
- *Which knowledge contributions do we actively excluded through the design of research protocols, and how, and why do we do so?*
- *What could and/or should have been asked?*
- *What was 'cleaned out', and why?*
- *What are the implications of choices, exclusions and 'cleaning out' processes, and which ontological politics do they forward or suppress?*

7. Conclusion

The articulations of *rigour-as-integrity* presented above are, of course, not distinct or separate - rather, they are strands which constitute and (re)constitute an overall integrity within research. To date, my experience has been that over-much emphasis has been placed on analytical rigour, straining and stretching the integrity and credibility of research as the analytical strand was forced to bear almost the full weight of rigour. This think piece brings focus back to aspects of rigour which have been systematically surrendered to dualistic systems of rationality which entrenched Santos's *Abysses* (2004) and Latour's *Great Divides* (1993). Through it, I invite their reclamation and (re)enactment. Fundamentally, I am calling for the redistribution of integrity across an (hopefully) expansive system of integrity which is oriented more strongly towards engaging ontological politics, commoning, building sanctuaries that we all, people, species, planet, might (re)claim, and futures which might be more coherently built towards common goods. It is the opening of a conversation, and an act of commoning. Through it, I issue an invitation to consider how we might build common knowledge through systems of commoning, with greater integrity and stronger coherence.

FIVE FORMS OF RIGOUR-AS-INTEGRITY

A mind map of key aspects and influences

RIGOUR AS ENGAGING WITH AND MAKING VISIBLE, ONTOLOGICAL POLITICS

Core Concept

Engaging with ontological politics is about recognising the **PLURALITY** of **ONTOLOGIES** that are always present.

It recognises that research always concerns choices about the realities we enact, and those we either set aside or actively produce as nonexistent.

Finally, it is about making our ontological choices conscious, visible, and more just.

Key Influences

This form of rigour draws on a wide range of scholarship, including:

- Mot (1999) Ontological politics
- Law (2004) Messiness of research methods
- Lather (2016) Rethinking ontology
- Amster (2015) Education & radical democracy
- Alcoff (1991) Speaking for others
- Lather (1986) Types of validity
- Andreotti et al. (2018) Knowledge politics

RIGOUR AS (RE)CLAIMING ONTO-EPISTEMIC IMAGINARIES

Core Concept

'*Rigour as (re)claiming onto-epistemic imaginaries*' is about enabling ontological generativity towards future possibilities.

It is about strengthening the integrity with which we leverage particular sets of ontologies and their politics.

It recognises that all realities leverage a set of onto-epistemic imaginaries, and that these imaginaries can be reconstituted and remade.

Key Influences

This form of rigour draws on a wide range of scholarship, including:

- Verran (1998) Ontic-Epistemic Imaginaries
- Santos (2004) Sociologies of absences and presences
- Querejazu (2016) Pluriversality and reknowing the world

RIGOUR AS (RE)MEMBERING AND BRIDGING ABYSSES AND GREAT DIVIDES

Core Concept

This form of rigour is about establishing and articulating systems of internal and external coherence within and between knowledges. It is about making visible, how legitimacy is constituted within and between knowledges in light of ontological politics at play (both internally and externally) It includes three aspects of rigour:

Rigour as Engaging Sociologies of Absences

'*Rigour as engaging sociologies of absences*' is about actively analysing for produced nonexistence, and bringing back into visibility, what has been produced as nonexistent.

Rigour as Internal Epistemological Coherence

'*Rigour as internal epistemological coherence*' is about making the internal bases of legitimization, within any particular knowledge, visible.

Rigour as External Coherence

'*Rigour as external coherence*' is about establishing the nature of the contextual issue to which an ecology of knowledges intends to respond, and generating coherence among knowledges.

Key Influences

This form of rigour draws on a wide range of scholarship, including:

- Santos (2016, 2009, 2004) Sociologies of absences and presences
- Latour (2004) Matters of concern
- Visvanathan (2006) Alternative science

RIGOUR AS ANALYTICAL INTEGRITY

Core Concept

'*Rigour as analytical integrity*' is about circumscribing epistemic activity in meaningful ways, as well as visibly acknowledging what has been produced as nonexistent, and why.

It is about making visible which ground has been claimed through such choices, and how they forward a particular ontological politics.

RIGOUR AS ENHANCING CONCEPTUAL INTEGRITY

Core Concept

'*Rigour as enhancing conceptual integrity*' is primarily about making conceptual choices visible for the choices they are.

It is about visibly acknowledging that conceptual choices are constituted to forward particular ontological politics.

Figure 2: Five forms of rigour-as-integrity