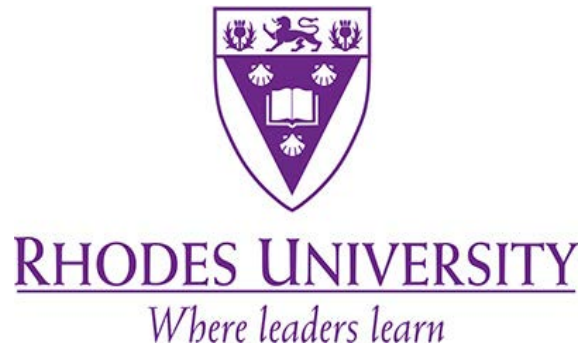




**Realist evaluation cases of the uptake and use of
citizen science tools for water quality management:
Vaal-Triangle public primary schools teachers
and Mpophomeni enviro-champs**

by

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Abstract

This study employs a theory-based approach to evaluate citizen science (CS) interventions in two distinct cases: the Mpophomeni enviro-champs and the Vaal-Triangle primary school teachers. These interventions were designed to foster *social learning*, enhance *education or participants' understanding of water quality impacts*, and promote *community or public participation* for improved water management. GroundTruth, a multidisciplinary consulting company with expertise in water resources and environmental engineering, collaborated as partners in these CS projects.

Utilizing qualitative realist evaluation theory, the study delves into the intricate context-mechanism-outcome (CMO) configurations for each case, seeking depth insight into the outcomes of these citizen science initiatives. Data collection involved interviews, document analysis, and participant observations to construct a comprehensive understanding of the interventions' impact.

In the case of the Vaal-Triangle primary school teachers, the CS intervention yielded positive results, significantly influencing teaching practices and instilling shared values for sustainable water quality management in both classrooms and the surrounding communities. However, the study revealed the need for continued evaluation and comprehensive dialogue among stakeholders, including teachers, school governing bodies, local municipalities, the Department of Basic Education, and the broader community to ensure the effectiveness, sustainability, and transformative potential of these interventions.

In contrast, the Mpophomeni enviro-champs experienced a different set of outcomes. The CS intervention catalyzed numerous opportunities for the volunteers, forging a collaborative relationship between citizens and the government. Despite their socio-ecological vulnerability, these volunteers exhibited remarkable resilience and willingness to contribute, calling for formalization mechanisms such as remuneration and skill recognition to sustain and enhance their participation.

This study provides insights into citizen science interventions, foregrounding volunteerism as a means of fostering fair and inclusive participation. It emphasizes the significance of combining social and classroom learning in achieving sustainable water quality management objectives. Furthermore, the research highlights the pivotal role of informed citizenship, which necessitates an understanding not only of environmental activism but also of effective political engagement to influence decision-making processes effectively. By challenging historical barriers and revealing new perspectives, this study offers a reflective thinking tool to advance transformative policy development in South Africa and beyond, promoting informed and responsible public participation in water quality management and fostering the sustainability of precious water resources.

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At the prime and core of everything : to God be the glory. A PhD journey is 'nie pap 'n vleis nie' – as we express the hardships of life's endeavours in South African Afrikaans slang. The pain of the PhD journey sometimes pierces through the mind, attacking the spirit and soul, and manifesting in the physical. Then it affects everything and everyone around. At the same time there were many exciting moments. If I did not have God, there would have been no way, and I mean no way, that I could have survived the PhD journal. May His name be glorified. Amen.

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“If you want to go fast, go alone. If you want to go far, go together.” (African proverb)

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Acronyms

CBWQM	Community Based Water Quality Management
CMA	Catchment Management Agencies
CMO	Context-Mechanism-Outcome
COGTA	Cooperative Governance and Traditional Affairs
CS	Citizen Science
DUCT	Dusi Umgeni Conservation Trust
DWA	Department of Water Affairs
DWAF	Department of Water and Forestry
DWS	Department of Water & Sanitation
IWQM	Integrated Water Quality Management
IWRM	Integrated Water Resource Management
miniSASS	mini Stream Assessment Scoring System
MSEP	Mpophomeni Sanitation Education Project
NWA	National Water Act of 1998
NWRP	National Water Resources Plan
RDP	Reconstruction and Development Programme
SADC	Southern African Development Community
SASS	Stream Assessment Scoring System
SCAR	Structure, Culture, Agency and Relations
SDG	Sustainable Development Goal
SGB	School Governing Body
UNEP	United Nations Environment Programme
UNSGAB-WS	UN Secretary-General Advisory Board on Water and Sanitation
WESSA	Wildlife and Environment Society of South Africa
WRC	Water Research Commission
WUA	Water User Associations

***Water no get enemy*¹**

Song by Fela Anikulapo-Kuti

T'o ba fe lo we omi l'o ma'lo
If you want go wash, a water you go use

T'o ba fe se'be omil'o ma'lo
If you want cook soup, a water you go use

T'o ri bba n'gbona o omi l'ero re
If your head dey hot, a water go cool on

T'omo ba n'dagba omi l'o ma'lo
If your child dey grow, a water he go use

If water kill your child, na water you go use
T'omi ba p'omo e o omi na lo ma'lo

Ko s'ohun to'le se k'o ma lo'mi o
Nothing without water

Ko s'ohun to'le se k'o ma lo'mi o
Omi o l'ota o

Chorus: Water, you no get enemy; Water, you no get enemy! Water, you no get enemy!

Omi o l'ota o
If you fight am, unless you wan die
I say water no get enemy
If you fight am, unless you wan die
Omi o l'ota o
I dey talk of Black man power
I dey talk of Black power, I say
I say water no get enemy
If you fight am, unless you wan die
I say water no get enemy
I say water no get enemy
Omi o l'ota o
Omi o l'ota o

1 Meaning of the song: This song is a metaphor of water - the virtues, usefulness and indispensability of water in life. Fela Kuti, a well known African musician, says if you want to take a bath and cook, water is essential to use. When your head hurts water gives you relief. He further explains the power of how water can simultaneously make or break oneself if a child drowned in water, parents are still compelled to use it despite the sad ordeal. And no one is capable of fighting or hating something as useful and important as water, otherwise one will die.

CHAPTER 1

POLICY REVIEW OF WATER QUALITY MANAGEMENT

1.1. Introduction

Water, in the words of the song that opens this thesis, is a ‘symbol’ of purification, rebirth, and reconciliation. It can, however, also be a source of contradictions, animosity and conflict. “Water, with its close connection with fertility and life, figures deeply in religious and metaphysical worldviews of nearly all peoples” (Jennings et al., 2009, p. 26). This deep, yet practical analogy, in essence, helped to germinate the outlook of this thesis. The issues of water are deeper than they seem on the surface. They need to be dealt with using care, sensitivity, empathy and the ethics of *ubuntu* (an African philosophical concept meaning reciprocity in mutual being).

This study, with its focus on the use and uptake of citizen science tools, was located within the locus of a partnership between GroundTruth, an environmental consulting company, and its collaborating partner, the Wildlife and Environment Society of South Africa (WESSA). These two organisations were awarded a contract by the Water Research Commission (WRC) to investigate Transboundary Water Ecosystem Management in South Africa and neighbouring SADC countries. The concern was that the deterioration of water quality had become a growing challenge affecting environmental, economic and social development, mainly affecting the development of disadvantaged communities. My involvement in the research focused on citizen sciences, working together with Ground Truth and WESSA, generating data in the context of the citizen science project as a whole. The PhD study was developed to generate in-depth insights using realist evaluation, as will be elaborated further across the study.

Since the introduction and adoption of citizen science tools in water quality management in South Africa, not much is known (except from the tools or environmental activist point of view) of the depth of their impact on wider socio-ecological and political issues in different contexts and circumstances (Matthews, 2018). The adoption of citizen science tools and practice were anticipated by Graham et al. (2014) to be potential tools for enabling societies to contribute to the SDGs, specifically:

- SDG 4: quality education through place-based and inclusive learning in public schools; and facilitating social learning and lifelong learning in communities;
- SDG 6: clean water and sanitation through efficient water use and water management, and

- SDG 17: through community capacity building, data sharing and monitoring; and accountability and systemic learning of issues.

The study was established to undertake evaluation research to probe how citizen science interventions are, or can better contribute to these intentions. At the time, there were no follow-up plans for the primary school teachers who were using the CS tools that were introduced by GroundTruth and WESSA, and while there were evaluation reports (Ward, 2016), there was no in-depth assessment of the CS tools and their use and impact upon the Mpophomeni community, hence this study was initiated to contribute with knowledge on this topic in these two case contexts (elaborated further below).

There was also a need to better understand the uptake and use of the citizen science tools for understanding aspects of sustainability and expansion. For this reason, I sought to design a study that could methodologically provide insight into the functional mechanisms that can enable CS tools to serve the needs of the different agents involved in water quality management. Hence, the focus of this study is on responding to the realist question: ***what works for whom under what circumstances, and why?***. This realist evaluation question became a central theme throughout the writing process, as elaborated further below, in Chapter 2 and 4, and in the study findings shared from Chapters 5-10.

1.1.1 An evaluative study

This study was conducted as an in-depth evaluative study to understand the context-mechanism-outcome (CMO) configurations influencing and shaping how Mpophomeni enviro-champs and the Vaal-Triangle primary school teachers took up and used citizen science tools for water quality management. CMO configurations can help to probe the question noted above with some depth in different contexts.

Even though the issue of improving water quality management was the same, the case study contexts were quite different. The initial data collection for this study was conducted within the GroundTruth project between July 2015 and December 2016 with support from the Water Research Commission as pre-doctoral research to inform the development of a PhD study. Because this work was to inform subsequent PhD studies, I requested and was granted permission from GroundTruth to draw on this data. The study was further expanded through citizen science workshops and a broader Water Research Commission (WRC) Community Based Water Quality Management project (cf. Lotz-Sisitka et al., 2022 for the final report of this project) in which I participated (see Chapter 4). My contribution to the broader WRC CBWQM project was to focus in more depth on issues identified during the pre-

doctoral research experience via the research questions stated in more detail in section 6.1 below, but introduced here at a broad level.

This study evaluated how citizen science (CS) interventions supported the uptake and use of citizen science tools offered by citizen science programmes implemented in two case study sites. Probing the initial ideas for the programmes and their background was important for a realist evaluation, so as to evaluate the CS programmes' merits and challenges under their context in which they were conceived. However, I also found it necessary to consider the evaluation of the CS programme's relevance within changing and evolving contexts. This intensive, realist evaluation was designed to respond to the following research question: **"Is it possible to improve the management of water resources through the uptake and use of innovative citizen science tools and interventions to engage with, measure and better understand the health of catchments?"** (Graham, Taylor, Pesanayi & Bruton, 2014).

The CS tools and interventions here refer to those developed by GroundTruth.² These tools were introduced to different stakeholders, at various times and contexts, for example in 2012/13 to a group of Vaal-Triangle Primary school teachers and around 2011 to the enviro-champs in Mpophomeni in KwaZulu-Natal. The question above formed the basis of the evaluation of the study.

Over time, the focus deepened as I progressed with asking this question – which could be answered superficially, or with a more in-depth understanding. My study sought to address the question at a deeper level, as is required of realist evaluations where issues of context (involving structures and cultures), as well as the mechanisms and outcomes resulting from the process, are all considered.

Figure 1.1 that follows shows sewage spillage into Mthunzima stream in Mpophomeni township, KwaZulu-Natal. This is the kind of water pollution the citizen science interventions wanted to address to improve water quality management.

2 GroundTruth is a multidisciplinary consulting company with a specialist focus on matters surrounding water resources, biodiversity and environmental engineering (<http://www.groundtruth.co.za/>). The company initially asked me to help them with the research on this intervention as part of the Water Research Council (WRC) citizen science project submission which formed the start of this study. GroundTruth also provided partial financial support for the study.



Figure 1.1: Sewage spillage into Mthunzima stream in Mpophomeni township
(from Ayanda Lepheana's presentation International Citizen Science Workshop, Howick, February 11, 2016)

The study's inception was based on the following GroundTruth premises: 1) the uptake and use of citizen science tools have the potential for creating an environment for **social learning** to take place amongst the participants; 2) the uptake and use of citizen science tools enable³ participants to acquire **education** about the impact of water quality and an understanding of water catchment issues; and 3) knowledge acquired through the uptake and use of citizen science tools has potential for **public/community participation** that can inform better decision-making leading towards improved water quality management overall. These three phenomena: social learning, education, and public/community participation were the threads underpinning debates across the thesis.

1.1.2 Policy, hydro-sociology and hydro-hegemony as background

In this introductory chapter, my objective was to gain a comprehensive understanding of the policy context by examining the opportunities and challenges associated with **social learning**, **education**, and **public/community participation** policy assumptions in water quality management. This is because policy is a critical structural and cultural factor that can enable or constrain uptake and use of citizen science tools, and water quality management.

³ The term "enable" here refers to the context as well as the processes that facilitate learning and understanding through the uptake and use of citizen science tools. It is a key term used in critical realism (see Chapter 2). Constrain means to impede.

I started with a policy review drawing on information that was already available and accessible, seeking to understand the histories of how things came to be, including international policies and international obligations, and how they were influencing and could be applied to the context of this study. In developing this understanding, I often worked back and forth between top-down and bottom-up views in an attempt to uncover mechanisms which may either constrain or enable the uptake and use of citizen science tools. Figure 1.1 illustrates the 'grounding context' of the study, namely the water pollution challenges that are the foundation of the citizen science interventions (refer to Chapter 5 and 7 for detail on water related issues and the rationale for the study) . The policy review considered international and local policies (i.e. plans and actions), structures and cultures that exist in the water sector that can enable, create or constrain conditions for **social learning, education, and public/community participation** through the uptake and use of citizen science tools for improved water quality management. I start by exploring how international policies, structures and cultures have taken up these phenomena – social learning, education and public participation. Firstly, I realised that to understand them better, I needed to acknowledge that social learning, education, and public/participation are processes in themselves, which are both complex and interdependent. I contextualised the discussion within the field of water quality management through citizen science practice.

Going through policy literature about water issues with a focus on water quality management was daunting because most policy is focused on the bigger picture – looking at water management in terms of catchment management, water resource management, or estuary management. There is far less that focuses specifically on water quality management and even more concerning was that little has been studied on the complexities of freshwater / surface water quality management at a small-scale level – such as looking at the smaller tributaries that feed major streams or dams. It is worrying that policy and research on small-scale tributaries appears to be overlooked, yet studies like this one demonstrate that they have so much to offer in terms of understanding water quality management issues at a grassroots level. This is because **small scale and in-depth studies such as this one, are better able to access the grassroots level where citizens encounter critical issues to do with water quality in their everyday lives**. Being small-scale does not undermine their complexity and significance in socio-ecological, economic, or educational deliberations.

To support the aforementioned assertions regarding the overlooked complexities of small-scale freshwater/surface water quality management, empirical evidence is essential. For instance, a study by Fisher et al. (2019) emphasizes the limited research on smaller-scale tributaries, stating that "despite their ecological significance, smaller tributaries are often underrepresented in water quality

management strategies" (p. 315). Hydro-sociology and hydro-hegemony theories can help to better understand and address the challenges faced by small-scale water management initiatives. Hydro-sociology delves into the social dimensions of water resource management, recognizing the intricate interplay between water governance and societal factors as is the case in this study. Villar-Navascués and Arahuetes (2020) underline the importance of this perspective, stating that "the lack of attention to the social, political, economic, and cultural dimensions of water conflicts and water policies has led to the production of the hydro-social cycle framework". The hydro-social cycle is a socio-natural process "by which water and society influence and transform each other along different spatial and temporal scales. As a result, water cannot be managed solely from technical and quantitative perspectives, since the environmental problems surrounding this resource are fundamentally social and political issues" (pg. 1). By adopting hydro-sociology, researchers can analyze the social processes, power structures, and institutional frameworks that influence small-scale freshwater management decisions and practices. Through its emphasis on critical realist evaluation and the cultural, structural and personal factors shaping water quality management through use and uptake of citizen science tools, this study can be positioned within this scope of study.

Similarly, the concept of hydro-hegemony as espoused by Zeitoun and others offers valuable insights into power dynamics and water governance. Zeitoun (2008) argues that hydro-hegemony "reveals how powerful actors control and manipulate water resources, often to the detriment of marginalized groups" (p. 22). This study focusses primarily on the experiences of marginalised groups in water quality management. Zeitoun et al. (2007, p. 43) state that "hydro-hegemony occurs when powerful actors can exercise control over water resources, their availability, and access, often at the expense of the less powerful". Incorporating this focus from hydro-hegemony in the investigation of small-scale tributaries and freshwater management practices focussing on the uptake and use of citizen science tools by marginalised groups, can allow this study to examine the influence of dominant actors in shaping water policies and resource allocation, as well as the potential for more inclusive and equitable water governance structures. The cases in my study, informed by the policy review in this chapter, offer hydro-sociological and hydro-hegemony insights at this level.

However, in social and education studies this view has been developed from Bhaskar's and Archer's views. In support of this, Murphy's (2021) view on hydro-sociology as a field aiming to bridge the human (i.e. agency) and water systems (i.e. structure) provides valuable insights. She suggested it as a response addressing the dualistic thinking within hydrology and sociology and theoretical debates about structure and agency. She sees reflexivity as a mediating tool, as proposed by critical realists like Margaret Archer (see Chapter 2). Furthermore, for educational research this perspective raises

pertinent questions about how to mediate between the hydrological and sociological fields and related thinking, which I focus on through the enabling conditions and the processes and issues emerging around the uptake and use of citizen science tools. And because it is an evaluation study, this study applies a critical realist approach that requires researchers to elaborate the Context-Mechanism-Outcomes configurations as these can reveal the interactions between structures (including water quality, policies etc.) and agency (including willingness to volunteer for example) and the relations between structure and agency, to deepen the connection and understanding of water and society relations.

As indicated above, policy is a potentially influential structural mechanism, hence I start this study with a policy review. For citizen science, this requires consideration of the policy-science-public interface (section 1.2) as well as the cultures and structures of policy at different levels (section 1.3-1.5).

1.2. Problematising the intersection: Policy-Science-Public; Public-Science-Policy OR Science-Policy-Public in the governance of socio-ecological systems?

The nature of this policy review and **problematisation of the order of the three phenomena in the context of the citizen science practice** was brought into focus due to a few factors concerning CS intervention circumstances. Firstly, hypotheses⁴ related to the potential of citizen science practice challenges conventional wisdom about the science-policy interface in environmental governance, specifically the aspect of knowledge co-creation for policy development and effective implementation for improving public service delivery (Graham, Taylor, Ward, Pesanayi, et al., 2014). The hypotheses suggest that scientists/researchers and policy-makers are not the only stakeholders at the centre of decision-making and knowledge (co-) production; **the public or the citizens** are as important.

Hence, there is a need for a shift of disposition from a strong science-policy interface (**B** in Figure 1.2 below) (Engels, 2005; Görg et al., 2016; Koetz et al., 2012; Van den Hove, 2007) to a policy-science-public interface (**A** in Figure 1.2 below). The major problem of leaving the public out of the picture or only understanding them in pairs (either **D** and/or **C** in Figure 1.2 below) in this study's context is that pairs have a tendency to pursue a one-sided or incomplete agenda when it comes to considering the

⁴ By hypothesis, I mean the potential of citizen science practice to include statements or predictions about the following: The ability of citizen science to: collect large-scale data, impact policy and public engagement and awareness, generate potential for scientific discoveries or insights, and address local or grassroots concerns for improving public service delivery (Graham et al., 2014). These hypotheses have been generated through substantive reviews and earlier examples of citizen science practice by researchers such as Graham et al. (2014).

role of citizen science, where the quest is to support the public to participate in water quality management (i.e. A in Figure 1.2 below).

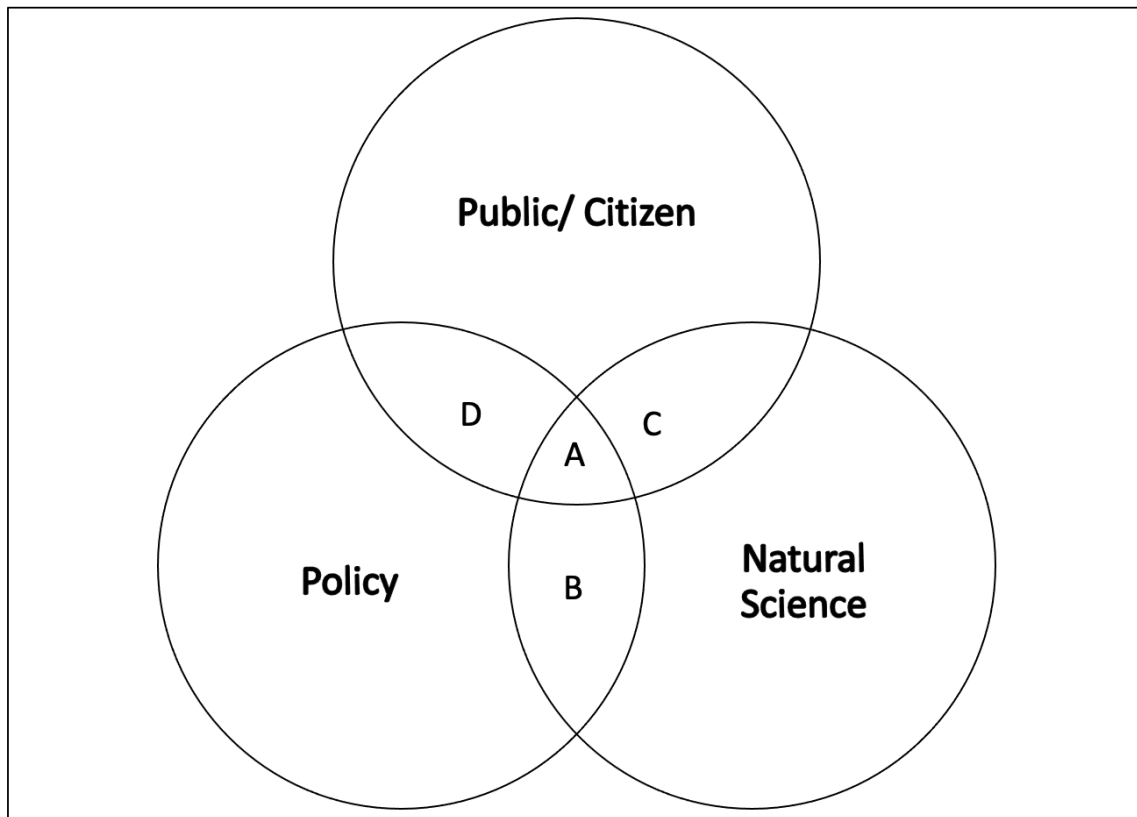


Figure 1.2: Potential public-policy-science interface relations in citizen science

Figure 1.2 demonstrates the heuristic of an ideal public-science-policy interface - represented by **A**. Here public, science and policy ideally align and are mutually respectful and supportive. The science-policy interface **B** has the potential problem of science not being able to translate itself into policy and vice versa, excluding relationships in the interface between science-public **C** and policy-public **D**. **C** is a potentially problematic relationship, especially if the two worlds of life and practice fail to come to understand each other in an ethical, mutually respectful sense, hence the need for reflexive science processes and the need for empathic learning from the public. Policy-public interface **D**'s relationship is mainly a political relationship which can exclude learning, ethics and fairness, depending on how policy is approached and implemented. In this study, I was particularly interested in exploring the interface between public-science-policy (**A**). I found studies relating to this interface under-developed in the citizen science arena, particularly in South Africa⁵.

⁵ For another illustration of this model and its application, refer to the PhD study of Vallabh (2022). This model was inspired by the ideologies developed in a project (Citizen Science SDG Lab: Strengthening the ecologies of

If a policy-making system is concerned about policy that is **issue-based, evidence-based, relevant, credible, and ethical, in the quest for the public's development**, then the public has to be included in the formula to better understand interface **A**, a critical point also made by hydro-hegemony studies (Zeitoun, 2008). Hence, for an evaluation study like this, it would make sense that the manner in which citizen science enables knowledge co-production and social learning will contribute to establishing its efficacy. One can assume that this would be most effective if such processes enables ongoing and iteratively inclusive processes that aims at empowering those involved. There is also evidence from other studies that reveals that for the public policy-making process to occur effectively, firstly, it needs to address contradictions (Gerston, 2010) and unclear processes. In South Africa specifically, Masango (2001) and Themba and Modupi (2020) have deepened this debate. They argued that empowering citizens with knowledge, skills and processes that enable active public participation is their **constitutional political right** (Constitution of South Africa, 1996). Local Government further supports this political right: this is evident in the Municipal System Act (32 of 2000), the White Paper on Local Government (1998) and the Local Government: Municipal Structures Act (117 of 1998) (Themba & Modupi, 2020). In short, the argument is to strengthen **participatory democracy** (ibid.).

Bachrach and Botwinick (1992) contend that participatory democracy involves creation of spaces (e.g. a workplace) that lead to a more egalitarian redistribution of power, and greater democratisation of the entire political process. It is this potential of citizen sciences that is of interest in this study. Here everyone, including researchers, have the responsibility for reflexively analysing strategies and tools that enable transformation (ibid., see also Dzur, 2012) including through **legal rights – i.e. a justice system** that offers a mode of fair participation and engagement. In South Africa, the justice system and Constitution recognise ubuntu as an integral part of constitutional values and principles that inform rights interpretation (Himonga et al., 2013). Ubuntu is very much concerned with **ethics that foreground mutual respect, trust and commitment** (refer to Chapter 3 for more). Hence, in this study, the concepts mentioned above can be considered the ingredients needed for increasing active participation in public policy-making processes.

For the reasons mentioned above, it matters how one understands, reflects and **clarifies the theory behind the order of the phenomena in the interface**. Hence, the order in which they were perceived and interpreted matters in this study. As Haraway (2016, pp. 12) stated, “it matters what ideas we use to think other ideas”. From the literature on environmental governance (Görg et al., 2016; Sarkki et

knowledges) that was co-developed by fellow scholars Jackie Alexander, myself, Priya Vallabh and Sherraine Van Wyk during our PhD studies (2019).

al., 2020; United Nations Environment Programme [UNEP], 2012; UNEP, 2017; UNEP, 2020) it seems that the main focus has been on the policy-science interface (B in Figure 1.2); based on this order, it could be understood and applied into two dimensions, as elaborated below.

Firstly, **in terms of power dynamics** – either science or policy holds power for decision-making on behalf of the public and either one of them is somehow a mediation tool. In this relationship, the public are excluded, and at worst perceived as passive and without agency. Secondly, they are explained in **terms of their roles in society**. In some of the international literature on strengthening the science-policy interface (e.g. UNEP, 2017 and the) UN Department of Economic and Social Affairs, 2021) the focus in environmental governance has been on the policy-science interface or science-policy interface, with very little deliberation on the **models that bring science, policy and the public together (A in Figure 1.2)**.

So far, the work of Bonn et al. (2018) on citizen science has picked up this relationship. Additionally, transdisciplinary sciences (cf. for example Brandt et al., 2013; Chilisa, 2017; Lang et al., 2012) and some forms of citizen science that emphasise social learning orientations (Alexander et al., 2019; Irwin, 1995; Martin, 2017; Shirk et al., 2012; Strasser et al., 2019) are addressing this relationship. In this study, I have focus on public contributions and voices in this relationship since South Africa has a history of marginalising local community voices in science and socio-ecological governance practices, especially prior to 1994.

By **positioning the relationality in A as the focus point of my study**, I sought to contribute to emerging epistemological understandings surrounding that recognise **the public's knowledge, agency and contributions to make in the decision-making process surrounding water quality management, and that they could be understood and also developed as such in practice**. The latter was the point of departure for this study's inquiry, and thus also the policy discussion that is elaborated below.

Meissner et al. (2013) noted that a normalised practice is that environmental management solutions are usually developed or spearheaded by natural scientists in isolation, while regulation and implementation plans and strategies are expected to be formulated by policymakers in isolation or with inputs/advice from natural scientists, while **at the receiving end, the public is expected to effect change**. Problematic in this approach is that in between the science and policy decision-making transactions, the 'realistic/grassroots' social processes get neglected or overlooked.

Secondly, the challenges with the two fields (science and policy/politics) is that **natural scientists and policymakers tend to have different mental models, cultures and processes of decision-making**

(Strydom et al., 2010) due to their particular areas of specialism and disciplinary or institutional cultures of practice. The challenge becomes even more complex when social learning pedagogies are merged into the picture. This does not necessarily mean that social sciences, natural sciences and political sciences cannot co-exist and be integrated in practice. It also does not mean that they cannot share a vision and work together to achieve a goal, as is being deliberated in transdisciplinary sustainability sciences literature and discourse (e.g. Lang et al., 2012). However, it suggests that there is a need to understand the different contexts and how they operate to identify opportunities and boundaries that **bring about effective integration for aspired outcomes**. Even more interesting and creating even more complexity in this study, is integrating the discipline of education – because the study in itself is an educational inquiry in environmental education, a field that encompasses various dimensions and is intricately interconnected with multiple disciplines. As highlighted by Stevenson, (2013), environmental education cannot be viewed as a linear or isolated field, but rather as a complex system intertwined with diverse fields. The overarching thesis and argument of this study provides insight into the dynamic nature of environmental education, highlighting its inherent connections and interactions with various disciplines and fields.

The contextual profiles and findings associated with each of the CS projects and their intentions, i.e. the teachers and enviro-champs show how environmental education plays a crucial role in promoting awareness, knowledge, and action towards environmental sustainability in this case water quality management; offering the ‘binding space’ for **A** in Figure 1.2 above. The study deepens understanding of environmental education through the social realist theoretical framework (Chapter 2), concepts associated with CS and educational strategies such as social learning, ubuntu ethics formation and relationality (Chapter 3), and insights into practical applications of environmental education (Chapter 6 and 8) as experienced by CS practitioners who are also community educators and teachers. It further offers analysis of issues enabling and constraining the educational processes involved in the uptake and use of CS tools, with recommendations for advancing citizen engagement at the policy-science interface (Chapters 9 & 10).

Environmental education as a discipline has an interest in mutual learning amongst publics, scientists and policy makers (Jenkins, 2003; Reddy, 2021). The relationships in **A** have always been on the agenda of the environmental education debate. This study continues Jenkin’s (2003) work articulating “the need for environmental education to address the relationship between scientific knowledge, authority (e.g. policy- and decision-makers) and public” (p. 437) and puts a strong emphasis on action.

The following sections in this chapter focus seek insight into the relationships in **A** in Figure 1.2 via probing ethical and substantive inclusion of the public in the public-science-policy relation. I review international and local water policies and agreements/ commitments that enable or constrain water quality management via citizen science practice, and focus in particular on the assumed **processes of public participation**. Where such mechanisms existed, the study looked at how they existed and if they were effective. I start with international policy which offers insight into the cultures of policy making (section 1.3), followed by a review of national policy relevant citizen sciences (section 1.4 and 1.5).

1.3. International policy and cultures: Mechanisms for enabling or constraining public participation in improving water resource quality management

South Africa has many international obligations regarding water (quality) management and development. Two of importance to this study are Agenda 2030 – the Sustainable Development Goals (SDGs) and *Agenda 2063: The Africa We Want* (African Union Commission, 2015). Both Agendas recognise that to achieve social-ecological development that is prosperous and sustainable, there is a need to respect and care for water and create conditions for equitable and sustainable use and management of water resources. Water (quality) issues are neither constant nor homogenous. Water is, or should be, at the epicentre of the Agendas’ aspirations, mainly because water is constantly in motion, it connects countries, it connects communities (the more-than-human included), it connects disciplines and sectors (e.g. politics, social, natural science, etc.), it connects knowledge(s), it connects different realms/realities (physical, chemical, biological, spiritual, etc.), and so forth (Biswas, 2004). Based on this background, I sought to investigate how these international policies support public or community participation towards meaningful change in water quality management.

Background: In 2004 the UN Secretary General Advisory Board on Water and Sanitation (UNSGAB-WS), led by the late Kofi Annan (a Ghanaian diplomat) at the time, was concerned that there was a misconception about “a difference between a drinking [or freshwater] water source that is only ‘improved’ and drinking water that is truly safe [and healthy]” (UNSGAB-WS, 2015). Annan foregrounded the ‘true meaning of safe water’ specifically for the African context in the UN conception of water policies. His concern was about the safety of drinkable water and the safety of water for all living organisms, such as those living in freshwaters. However, even today, the concept of ‘improved’ water persists, and **the concept of what constitutes ‘safe’ water is not clarified; at the same time, it**

is being undervalued for both the human, non-human and other living beings. Ignoring the safety of water, in general, could be fatal to water quality and quantity developments. Keeping water resources safe and healthy is not only for the sake of human consumption or economic value. It is also vital to keeping the environment healthy in ways that protect ecological integrity. If water is life, then it means it is life to all – humans and non-humans included.

Since Kofi Annan raised his concerns, it has become even more evident that international discourse around water issues – such as water quality and sanitation – lacked in-depth contextual political and socio-ecological understanding of water issues and the related dynamics in local communities in Africa (UNSGAB-WS, 2015). What was more concerning, **an in-depth systemic understanding of long-term water issues that persist outside of international funded projects was missing** in Integrated Water Resource Management (IWRM) projects, for example.

Where water quality was seen to have been improved, it was not explained how this was evaluated, or for what purpose it was considered ‘improved’. Instead, in many cases, African water projects were concerned with ‘ticking the box’ in order to move on to another project or issue (UNSGAB-WS, 2015). As mentioned earlier, **water is constantly moving and/or changing, and so are its issues.** As a result, water-related projects should not be treated as once-off projects. Instead, there was and still is, a need to treat water-related projects as part of ongoing programmes. This is an essential aspect to consider for an evaluation study like this one.

Another concern raised by the UN Secretary-General Advisory Board on Water and Sanitation (UNSGAB-WS, 2015) was a mismatch between global visions for water and sanitation management and their implementation at the level of African countries’ local governance. UNSGAB-WS explained that the policymakers who were allies of the UN tend to treat water or water issues as **“only the marginal issue”** even when water is a critical issue for socio-ecological developments (ibid.). Contrary to these views, water (quality) issues are very serious, sensitive and cannot afford to be overlooked, especially in Africa. Because of this indifference, the degree of agency between the Africans and the rest of the world become conflicted. Access to participation through public participation also became inhibited and/or undermined (refer below to the history of public participation in IWRM).

The challenges mentioned above demonstrate how international policies and intentions can sometimes hamper the access and efficacy of public participation and how this impacts upon those who are most affected on the ground. Therefore, the UN Secretary-General board (UNSGAB-WS, 2015) urged water (quality) researchers to critically and carefully interrogate how priorities in policies were developed. They encouraged an in-depth understanding of the dynamics in a ‘full-scale water-

cultural (agency and structural) revolution within the UN' (ibid.) before adopting any idea. Awareness of such views and contexts came to the fore when African members formed part of the committee and took leadership. Being conscious of who forms part of international committees constituents is also key to this evaluation study to see how and where the influence of global policy processes occurs, and how certain goals are prioritised (or not). This view is helpful in this study to seeing what can work **for whom**, when, under what circumstances and for what purpose.

As shown by the defining of the SDGs and the need for local reporting on these, political dynamics at the international policy level have an influence on who, what and 'when' (e.g. year 2030 SDGs) things should happen; **they act as an 'environmental moral compass' or a 'code of conduct'** for countries affiliated to them. Such policy developments continue to be seen as a 'good' mechanism to keep socio-ecological matters in order, but tend to lack differentiation at the level of public participation.

To further probe how international policies or agendas have influence on the access and efficacy of participation in water quality management decision-making, this study considered two fundamental trends that mark the evolution of the UN World Water Developments Reports (UN-WWDR) from 2003 until 2019. The first relates to reporting systems, and the second relates to the terminology used in the policy.

1. **Reporting processes and mechanisms:** From 2003, the UN World Water Developments Reports (UN-WWDR)⁶ were published every three years until 2014, when they began to be published annually. The challenge was that, if the public or community were to wait to be **informed** by these scientific reports as mechanisms to allow them to participate and make informed decisions, they would sometimes lack adequate access to relevant information on time, hampering agential processes. In this context, hampering agential processes suggests that simply providing information does not automatically result in individuals taking action or bringing about desired changes. The availability of information alone does not empower individuals or enable them to make informed decisions. Moreover, it indicates that delayed access to information can further impede individuals' ability to exercise agency or take purposeful action. Delayed access to information may hinder their capacity to make timely and effective decisions, potentially exacerbating the challenges they face in initiating change. Moreover, they would also be cut out of opportunities for participation as issues emerged. While there have been attempts to increase the reporting and reduce the gaps between

6 UN World Water Developments Reports (UN-WWDR)
<http://www.unwater.org/publicationcategories/world-water-development-report/> accessed 27/02/2018)

reporting periods, these reports still offer limited access to information. In many cases, water issues manifest in their own ways and times. Often this is faster than research processes operate and faster than the rate at which information is produced or accessed.

The issue of water issues manifesting faster than research processes and information production or access is a challenge that can be observed across the environmental landscape and knowledge production as a whole, it is not just limited to water issues. Environmental challenges, especially where humans are involved often evolve rapidly and require timely responses. However, the research process and information dissemination can be time-consuming, resulting in a lag between emerging issues and the availability of scientific insights or actionable information. This time gap can pose challenges for addressing environmental issues effectively and implementing timely solutions. It highlights the need for improved communication, collaboration, and knowledge exchange between researchers, policymakers, and practitioners to bridge the gap and enable more responsive and adaptive approaches to environmental management. It also surfaces the demand for citizen science approaches as access to information can be more directly acquired by citizens in the practice of water quality monitoring (Graham et al., 2014). Thus, while more general reporting is useful for periodic perspectives, there may be a need for another *type* of analysis and reporting that is more immediately engaged with at the grassroots level. These observations raise questions around the kinds and processes of **public or community participation** required, i.e. whether they needed to be constituted as **‘reactive’, ‘proactive’, or ‘co-participatory’** in decision-making processes for improving water quality management.

-
2. **Use and meanings of terminology:** A second issue relates to the use and meaning of terminology such as ‘decision-makers’, ‘stakeholder engagement or participation’, and ‘public participation’ which lack consistency in these reports. Sometimes terminology was used interchangeably, with different meanings. For instance, it was clear that the term ‘public’ and ‘stakeholder’ carried different meanings (2003 report) because, at some point, they were used in the same sentence implying different, separate roles. ‘Stakeholder’ implicitly referred to institutions or organisations. It was only from the 2006 report onwards that the UN adopted the concept of public participation from Integrated Water Resource Management (IWRM). In the 2014-2017 reports, the term ‘stakeholder participation’ meant participation of “lay public, civil society, faith/religious leaders, local communities, farmers, teachers, politicians, community, and representatives of federal and state governments and municipal institutions”. These descriptions indicate changing roles, responsibilities and accountabilities

for 'stakeholders' before 2006 and between 2014-2017. This shift raises the question of implications for public or community participation processes and ideologies in managing water issues at a global level. The importance of noting the shift in terminology in IWRM gains significance in this study because it reflects underlying theories that differently (e.g. the theory of what a 'stakeholder' is), sometimes separately, govern translations of these concepts in governing implementation at national/local level as well as in different contexts (Mehta et al., 2014). This can be seen by the adoption of similar discourse in recent Integrated Water Quality Management (IWQM) policy in South Africa and the SDG reporting processes (discussed in more detail in section 1.4.1. below).

Challenges in IWRM as a tool for public participation: As mentioned earlier, UN-water has adopted IWRM as a tool for improving water resource (and quality) management. IWRM has become a guiding conceptual framework for water resources management globally. For this study, considering IWRM is crucial as it emphasizes public participation and has guidelines on how public participation should take place in water resource management decision-making. The public participation approach embedded in IWRM guidelines has **informed the establishment of Catchment Management Agencies (CMAs)** in South Africa (cf. Lotz-Sisitka & Burt, 2006), providing central platforms for public participation in IWRM (ibid.). The principles of participation embedded in these guidelines have also **encouraged significant water sector reform** (Lotz-Sisitka & Burt, 2006).

However, policy implementation remains problematic (Biswas, 2004; Mehta et al., 2014) because processes remained centralised and lacked localised level engagement with water quality issues (Woodhouse, 2012). Lotz-Sisitka and Burt (2006) noted that while the legislation that cemented the structuring of participation at a CMA level in fact promotes a decentralised approach, the problem lies in the complex structures necessary for this decentralisation approach as legislated and that more needs to be done to develop the capacity and agency of people across the system at all levels to make such a policy work. They also note that legislating participation does not necessarily lead to participation in practice. This points to a need to better understand the CMA cultures and structures as these relate to IWRM, as these were being transferred into practice.

Another challenge with the IWRM approach is that it is not clear what exactly is integrated into the concept of IWRM (Biswas, 2004; Mehta et al., 2014) and what is excluded. Mehta et al. (2014) commented that this made **transdisciplinary and integrated learning and collaboration difficult in practice**, which also affected how the public participation and social learning it claimed to promote unfolded (or did not unfold).

Lastly, the challenge with IWRM is that it tends to give power to one institution or structure over others (ibid.); consequently, **inclusivity and fairness become difficult to integrate**. For instance, in Zimbabwe, they mentioned that the adoption of IWRM was influenced by socio-historical forces (e.g. political) beyond that of the water sector (ibid.). Consequently, participation of the marginalised, whether politically or epistemic, was overlooked. Because of such reasons, IWRM in the southern African countries remained largely abstract and superficial in practice (Biswas, 2004). Some would say it has even been abandoned or questioned as a concept for water resources management and as an ideal universal solution (ibid.). While the technical aspects of IWRM could have been abandoned or poorly implemented, the principles of how public participation ought to be conducted persists as a relevant focus for water quality management, hence it being a key issue for investigation in this study. The section below elaborates further.

1.4. Cultures and structures that exist to enable or constrain public or community participation in South Africa through citizen science practice for improving water quality management

The question of public or community participation in water quality management through citizen science practice in South Africa has a dual focus in this study. Firstly, I undertook an inquiry into the tools and how they may help diverse publics, communities or citizens engage in various kinds of participation in water quality management. Secondly, I undertook an inquiry into the culture(s) of public or community participation in the decision-making of water quality management in these contexts and considered what processes and resources enable or constrain participation through citizen science tools (see questions in section 1.6 below).

To fully interpret the above, it was vital to include insight into the dynamics of the political history of South Africa and how it has affected citizen, public or community participation, especially in water (quality) management. In this section, I focus on the context of IWRM and how it came into South Africa. Later I explain how structures like the Water Research Commission (WRC) fit into the picture. I then explain how the history of water policies and laws have influenced public and community participation.

1.4.1. History of public participation in the water sector

Equity and fair participation by the public or citizens in decision-making related to water issues has been a long historical challenge in South Africa, hence the emphasis on participation in the National Water Act (NWA) of 1998 (Water Research Council [WRC] & Department of Water & Sanitation [DWS], 2012). The pressure for adopting fair and equitable participation did not start with the NWA of 1998,

but emanates from a long history of exclusion of the majority of South Africa's people from access to and management of national resources (including water). With the transition to democracy in 1994, the political dispensation sought to reflect democratic principles in all spheres of governance and life as indicated in the country's Constitution of 1996 (South Africa, Constitution. 1996). Further articulation of the concept of public participation was elaborated upon, but such details were mostly found in political law, such as in the South African legislative sector⁷ in issues of public participation/engagement and implementation. Because the concept of public participation was aimed at addressing fairness in political negotiations, the approach developed is more suited to the political context than to a practically engaged sphere such as water (quality) management in the environmental sector. This means the concept of public participation, originally designed to address fairness in political negotiations, may not be well-suited for practical engagement in sectors like water quality management within the environmental field. Water management often involves technical complexities, scientific considerations, and the need for specialized knowledge. Public participation approaches, which prioritize inclusivity and democratic engagement, may not always fully address the practical requirements and expertise needed for effective water management decisions.

The South African Legislative Sector's public participation/engagement and implementation document (2013) which sought to articulate approaches to public participation in support of democratic praxis, drew on **Arnstein's (1969) philosophy of the ladder of citizen participation** (South African Legislative Sector, 2013, p. 91). It articulates 'levels' or a hierarchy of participatory approaches that include informing, consulting, involving and collaborating as forms of participation. Arnstein believed that participation processes that are democratic ought to redistribute power, otherwise they are technical only (Theyyan, 2018). However, there were two problems with Arnstein's approach: firstly, within the process descriptions, it is not clear **what power is to be shared or distributed between those who are involved, or how this is to occur**. While drawing on Arnstein's framework, the legislative sector document (South African Legislative Sector, 2013,) reflects that **power, or control of decision making, resides with government** – ultimately the ruling political party. Arnstein's framework also does **not clarify how and when one should move from one level to another**. The

7 The South African Legislative Sector is a unit consisting of the National Parliament of South Africa and all the Provincial Legislatures. This unit is mandated to deepen representation and radical democracy through overseeing many transformatory legislative laws and policies. Amongst the policy priorities are Nation Building developing representative democracy and deepening public participation. Through Legislative Sector Support they published a Journal of the South African Legislative Sector in 2014. It published original academic articles targeting audiences in the field of legislative, government, civil society and academy. The main goal of the Journal is to publish research articles based upon legislative and parliamentary studies with a focus on the South African legislative context. The Journal aims to enhance dialogue, stimulate debate and contribute to the body of knowledge pertaining to legislative sector matters in South Africa (Plaatjie; Borchard & Layman, 2014).

approach also assumes only one kind of participation, which **relies heavily on communicative action or a conversational or verbal approach (i.e. deliberation approaches)**. Other critiques of Arnstein's model, e.g. Collins and Ison, 2006, in Theyyan, 2018) have claimed that it is devoid of context and where the issue is undefined, "Arnstein's ladder provides few insights into how participation might be progressed as a collective process between all of the stakeholders involved" (Theyyan, 2018, p. 245). Therefore, it is not clear whether this model works or not for both the South African government and its citizens, as well as in the issues of water quality management.

Another problem is that the South African bodies that regulate and implement water quality management **do not seem to agree with the meaning of the concept of public participation**. As in the UN context mentioned above, in South African legislature the concept of public participation has been used interchangeably with stakeholder participation, community participation (WRC), and citizen participation. The problem appears to be that the meaning and theory of these concepts are not clear; it is not even clear if they are effective or not or how they each differ. Hence this study seeks to carefully explore the concepts of citizen, public or community participation in detail for the relevance this has to citizen science practice in the water management sector.

Amongst other limitations, due to lack of in-depth investigations of water quality issues, South Africa has a **backlog of data** that is either falling behind or absent **on the management and status of water quality of rivers and streams, especially in rural and peri-urban areas** (Verlicchi & Grillini, 2020). This backlog could be problematic for water quality management in South Africa because types and sources of water resource pollution may remain unknown or unreported. Furthermore, these unknown sources can consequently create pollution risks, which ultimately risk the degradation of our water resources – as is currently the case. The extent of water risk related to water quality or quantity, especially if it remains unknown, can regress water development planning (UNSGAB-WS, 2015), as well as efficacy of citizen, public or community participation in water quality management. Here the role of structures responsible for citizen science tools and public participation have significance. I discuss the main structures governing IWQM in South Africa to elaborate and provide perspective on their roles.

1.5. Main structures governing IWQM in South Africa

1.5.1. Structure 1: South African Department of Water and Sanitation (DWS)

Water quality management policy and institutional structures are regulated by the DWS⁸, all of which are guided by the National Water Act of 1998. Through this Act (and the wider influence of IWRM as reported on in section 1.3.1. above), Catchment Management Agencies (CMAs) were formed as the statutory bodies for implementing water quality management at the catchment level. The CMAs then became the custodians of the National Water Resource Strategy (NWRS 1 & 2) (Department of Water and Forestry [DWA], 2004), which was also informed by the international discourse of IWRM. Creating CMAs aimed to decentralise responsibility and power for water resource management (ibid.), and at a local level, water user associations (WUA) were established. More than anything, CMAs were assumed to be hands-on bodies (in addition to WUA) overseeing ground-level water issues systemically. And because of its persuasive authority (as compared to the WUA), the assumption is that they can create platforms for citizens to participate fairly, where their voices can be heard (South Africa. National Water Act, 1998; Pegram & Mazibuko, 2003; WRC & DWS, 2012).

In the beginning, since the National Water Act of 1998, the institution of CMAs was envisioned with 19 expected to be implemented by the year 2000 (Munnik, 2020). This was later reduced to nine: Limpopo, Olifants (Mpumalanga Province), Inkomati-Usutu, Pongola-Umzimkulu, Vaal, Orange, Mzimvubu-Tsitsikamma, Breede-Gouritz and Berg-Olifants (Western Cape) (Water Research Commission, 2017) (refer to Figure 1.3). So far, only two, the Breede-Gouritz and the Inkomati-Usutu CMAs are functional, with the rest being regarded as ‘proto-CMAs’, being unable to operate to the same effect as CMAs due to reasons that are politically-influenced, some administrative and some economic (ibid.; Munnik, 2020). This reveals a significant problem for the advancement of citizen-based water quality management. If CMAs were the only (structural) mechanisms for allowing citizens and informal organisations to participate, then their participation is limited and constrained by the functionality (or dysfunctionality) of the available CMAs (Lotz-Sisitka & Burt, 2006). This is further compounded by the geographical location and size of the CMAs – especially when considering the complex hydrogeological systems that exist in South Africa (WRC & DWS, 2012). Complex hydrogeology systems include transboundary aquifers, transboundary surface and ground water, human capital, etc. (Pietersen & Beekman, 2016). As this structural set-up is not functioning optimally, in this study I seek to consider other mechanisms working in parallel with the CMAs that can allow citizens and informal organisations to participate in water quality management. It might take a while

8 The South African Department of Water Affairs and Forestry (DWA) was formed in 2009. In 2014 the name was changed to Department of Water and Sanitation (DWS). From 2019 to 2021 it became the Department of Human Settlements, Water and Sanitation (DWS-HS). It has now returned to being called the Department of Water and Sanitation (DWS).

to see if CMAs work or not, but water quality issues continue to expand (especially in the 13 CMAs which are currently not operational); the integration of other platforms is thus critical.



Figure 1.3: South African Water Management Areas
(accessed from <https://breedegouritzcma.co.za/>)

1.5.1.1. Overview of IWQM policy, strategy and implementation

National Water Resources Strategies 1 and 2 were put in place in 2004 and 2013 respectively. However, **they still did not address water quality management and water quality issues** (Department of Water & Sanitation [DWS], 2017a). In response, an Integrated Water Quality Management (IWQM) policy was established in 2017, after an extensive review of international and local policies and strategies relating to WQM. The establishment of the 2017 IWQM policy was intended to support the National Water Resources Strategy 2 (ibid.). More importantly, the IWQM policy, strategy and implementation plan (DWS, 2017a; DWS, 2017b) included detailed emphasis on water quality and its management. The IWQM policy, plan and strategy (2017) were designed to find more innovative ways of managing water quality (DWS, 2017a). Through **these three documents, public or community participation through citizen science practice was recognised and promoted.**

Challenges related to the lack of adequate social perspective in the IWQM policy. For instance, given the complexity of water issues, the examined documents acknowledged the significance of considering their social implications (pg. 106) - hence the development of scenarios, in the strategy document (2017). However, they fell short in adequately addressing their potential impacts on diverse communities and vulnerable groups. Such considerations are crucial for policies seeking to enact societal transformations and promote the common good.

- ❑ There was emphasis on technical aspects focussed heavily on scientific and engineering aspects, such as pollution control, water treatment technologies, and monitoring methods (strategic issues 5 -7). While these technical elements are essential, they overshadow the importance of considering social and behavioural factors. Social sciences provide valuable insights into human behaviour, decision-making, and the social dynamics that influence water use and pollution.
- ❑ Consequently, the lack of transdisciplinary and interdisciplinary collaboration resulted in a significant knowledge gap concerning societal behaviours and preferences related to water usage and conservation. To bridge this gap, the documents should have demonstrated a comprehensive integration of social science methodologies (pedagogies) aimed at understanding human behaviour, societal responses, and the underlying social drivers, which are essential for the effective long-term management of water resources.
- ❑ The absence of sufficient data availability and prioritization regarding the social aspects of water management (refer appendix B) further detracted from the importance of addressing long-term behavioural and social changes necessary for sustainable water resource management.
- ❑ It is worth noting that political considerations and administrative priorities may exert influence on policy development, particularly concerning the aforementioned issues. If inputs from the social sciences are not perceived as politically expedient or administratively feasible, they risk being deprioritized or excluded from policy frameworks, thereby potentially compromising the efficacy of policy implementation and overall impact.

In light of the above-discussed deficiencies, the development of social and environmental education policies and methodologies, with a strong emphasis on inclusive learning involving all relevant stakeholders, emerges as a crucial approach. By promoting comprehensive education and awareness initiatives for all stakeholders including communities/ the public (i.e. improving strategic issue 11), these policies can foster a deeper understanding of the interplay between social dynamics and environmental sustainability, encouraging informed decision-making and active participation from all stakeholders involved in water resource management.

The IWQM strategy, informed by the IWQM policy, recognises the need for a water governance approach that is “integrated, inclusive, coordinated, aligned and adaptive” (p. 28) (DWS, 2017b). Concepts such as integration, inclusivity, etc. hold deep meanings. For instance, during the NRF-Future Earth SDG Lab for citizen science for the common good (Alexander et al., 2019), the notion of inclusivity was described as a process that intentionally and reflexively incorporates different knowledge(s), varied participation and participants, processes and practices (e.g. methodologies), etc. To make these concepts practical, mechanisms and systems put in place should **allow co-learning, co-creation, and co-adaptation for a sustainable approach** (Plaatjie et al., 2014; Alexander et al., 2019). However, the IWQM documents lack social science, learning and citizen participatory engagement methodologies (cf. also Lotz-Sisitka et al., 2022) which opens the opportunity for social and environmental educationists to further expand the framing of the degree and quality of citizen participation in water quality management. Hence, this study is significant.

The challenge with the dominating natural science approach and the government's approach for citizen participation in the IWQM policy is that the direction of **integration and implementation process remains centralised where power resides in the government (DWS) which still controls how decisions should be made**. For a complex issue like water quality management, this cannot be sufficient. The IWQM strategy recognised – in policy if not in practice – that there is a need to move from authoritarian control of water quality management to ‘holding hands’ where regulatory management and participation of citizens is highly valued (DWS, 2017a, p. 27). This shift in orientation appears to arise from an understanding that authoritarian control was not working.

Water quality management is not a once-off problem. It is an ongoing problem that is not always visible to the naked eye; it is not predictable and it cannot be solved by one discipline (Biswas, 2004). Biswas (2004) recommends exploring options for IWQM at different scales (Biswas, 2004) and through the use of different approaches. For instance, there has been much emphasis on policing and monitoring addressed at a level of industries or municipalities contaminating streams with toxic chemicals, which was definitely necessary e.g. incentive-based regulation blue and green drop certification programmes (DWS, 2014a; DWS, 2014b). Yet **there was little emphasis on creating a culture of encouraging small households or individuals to develop or revive attitudes of respecting and caring for water bodies and preventing their contamination**. This is vital – because a stream is polluted not only by significant volumes of contaminants, but also with things considered by current legislature to be trivial – e.g. tipping disposable nappies or waste into a stream – cf. EMG case studies

(Plotka-Wasyłka et al., 2022; Rahat et al., 2014) – which in turn reflect common perceptions and behaviours. **A more socially engaged view offers a lens and mechanism with potential to enhance water quality management** and part of the reality of ordinary citizens, diverse public(s) and communities, as reported on in a study on citizen engagement with the National Water Resources Plan 2 (NWRP2) (Lotz-Sisitka et al., 2018; Wilson & Pereira, 2012). This can allow communities to explore their own perceptions and behaviours and improve ways of participating in community-based water quality management (Lotz-Sisitka et al., 2018; Lotz-Sisitka et al. 2022).

If the politics of water quality management bring together the fields of natural science, social science and economics, while encouraging democratic inclusive public participation and engagement, then from a social perspective it appears that the IWQM documents may be lacking a platform to engage such forms of praxis. For instance, in their economic cost analyses for water quality management, the IWQM policy documents appeared to **lack translation of economic analysis (i.e. economic data and behaviour) into social explanations, leading to economic reductionism**⁹ that may be inadequate for enabling meaningful socio-economic development.

Here, economic reductionism refers to is the tendency to reduce complex phenomena or issues to purely economic factors or explanations, neglecting other relevant social, cultural, and environmental dimensions as elaborated further:

- **Limited Analysis of Economic Costs:** For instance, DWS (2017a) explains the economic costs created by eutrophication and salination in this manner: at the Middle Vaal Rivers desalination was estimated to cost about R80.5 million to R183 million per annum with overall government expenditure of about R18billion (DWS, 2017a). The analysis ended at that level, framed in millions and billions of Rands, failing to reveal what is involved in the process of salination and desalination. A social analysis would have included information on how and who is involved and how this can be broken down. Salination and desalination are different processes and their causes are processes too, not events. Collective or individual human behaviours, actions and attitudes are involved. A social analysis offers greater transparency and transdisciplinarity in policy arguments.
- **Neglect of Non-Human Life Forms:** The emphasis in the IWQM documents tends to prioritize human livelihoods, while overlooking the critical impact of water pollution on non-human species. This skewed emphasis represents economic reductionism by neglecting the broader ecological implications of water quality management. Thus, IWQM documents also need to emphasise the

⁹ Economic reductionism is based on the premises that every social analysis has an economic explanation.

culture of understanding that poor water quality does not affect human livelihoods alone – it also greatly affects non-human life forms (DWS, 2017a). The emphasis of this culture is pivotal. Poor water quality persistently affects other life forms, especially inland aquatic biodiversity, which, according to the recent National Biodiversity Assessment (NBA) of 2018 is a critical issue in South Africa (SANBI, 2019). For example, SANBI (2019) noted that inland freshwater biodiversity has declined through pollution: “Water pollution has dire, long-lasting consequences for aquatic organisms and hence ecosystems function. The Olifants River, which flows through the Kruger National Park, is a prime example of a river at the receiving end of a heavily utilised and degraded landscape. The impact of pollutants entering the river system have led to the demise of Endangered species such as the Nile Crocodile (*Crocodylus niloticus*)” (p. 96). This raises the importance of considering water quality management as a common good practice that reaches beyond human necessities, a perspective which needs to be promoted or enhanced, as argued by the South African National Biodiversity Institute in the NSA (SANBI, 2019). The "ecological economics" framework, as advocated by Costanza et al. (1997), emphasizes the integration of ecological and economic perspectives, challenging the narrow focus on ***economic growth and highlighting the need for a more holistic understanding of human-environment interactions.***

- ***Limited Consideration of Ethics and Morals:*** Another aspect that seems to be either implicit or overlooked and undervalued in current IWQM strategy is ethics and morals that link human health (through good water quality) with human dignity (NDP strategic target 2) and how these can be linked to ubuntu, a “fundamental constitutional and indigenous value” (Netshitomboni, 1998) that demonstrates a democratic society and democratic participation in water quality management. This is an important element that enables one to understand access to good water quality as not only a ‘constitutional basic right’ and also realise its value for resuscitating, restoring, maintaining and sustaining human dignity. The **IWQM strategy includes a relationship between poor human health and death of the physical body, but it does not explicitly look at the relationship between poor human health and death of ‘the self’, dignity or ‘ubuntu’.** Hence this focus can potentially provide a perspective of social understanding and value that goes beyond a science-technical ontology of water quality management. This consideration can also complement a system-based adaptive management approach for water quality management as proposed by the IWQM policy and strategy. In terms of economic reductionism debate, the above discussion means the current IWQM strategy does not explicitly address the ethical and moral dimensions of water quality management, particularly concerning human dignity and ubuntu, a fundamental indigenous value in South Africa. By not acknowledging the deeper social understanding and values associated with access to clean water, the strategy may inadvertently perpetuate an economic reductionist view,

focusing primarily on technical aspects. For example, studies on income inequality and social exclusion, such as those conducted by Wilkinson and Pickett (2009), ***demonstrate how a sole focus on economic factors can mask underlying social disparities and hinder efforts to achieve inclusive and sustainable development.***

- ***Lack of Holistic Partnerships:*** Recognition of public or community participation (and volunteerism) in water quality management through the use of citizen science tools by the government can be one of the mechanisms that helps in overcoming socio-ecological problems such as mitigation of poverty through creation of employment via water programmes and ensuring quality human health (DWS, 2017a). As long as this is not done, the aspiration for achieving goals such as Sustainable Development Goal 6, National Development Plan, Integrated Water Quality Management Strategy, etc. may not be realised (Lotz-Sisitka et al., 2022). Public or community participation of the kind envisaged in the IWQM policy is not only about empowerment of individuals. It is also beneficial to the state through the social development, social cohesion, citizenship reinforcement and unity that are created (Turcotte & Gaudet, 2013). For example, in 2010 it was estimated that ‘formal’ job loss due to poor water quality was about 200 000 employees (Department of Water and Sanitation, 2017d). At the same time, it is predicted that water quality management has the potential to create more jobs, especially when looking at the skills needed in the supply chain in the water sector. Both perspectives are needed in order to make informed decisions for taking citizen science participation forward. This means, the strategy emphasizes institutional and regulatory approaches and encourages cooperation between government, the private sector, and civil society. However, it may not fully recognize the need for stronger social and values-based approaches that foster partnerships beyond the economic realm. Scholars such as Hall (1993) argue that economic reductionism can influence policy decisions and result in unintended consequences. They highlight the importance ***of considering political and institutional factors that shape economic policies and outcomes.***

In light of the above, and the difference in the socio-economic background of peoples, it is also important to consider that water quality issues affect different human beings differently, depending on age and gender (DWS, 2017b). DWS (2017b) indicates that different pollutants affect men and women differently, although there has been little research in this area. Who is more affected by poor water quality and how that plays out could influence how these different groups can participate in water quality management. Furthermore, it is important to explore this area in terms of a response to the Sustainable Development Goal (SDG) 5: Gender equality – how does gender equality and inequality influence participation water quality management? (Mehta et al., 2014).

Besides these issues, there are some aspects of the IWQM that are positive from a public participation point of view. Goal 3 of the 2017 IWQM strategy (DWA, 2017a) recognises water quality management as a practice. It recognises that this practice is not homogenous but involves different practices that work as a system. It mentioned that the indicators of success or enabling factors of these practices have to be measured to show the practicality and progress of water quality management.

Furthermore, The IWQM strategy (DWS, 2017b) emphasises institutional incentive-based regulations and training programmes – in particular for those who are already employed by government e.g. municipalities. An example of this would be through blue-, green- and no-drop accreditation.¹⁰ This is important, but since water quality issues do not affect only those in government, there is a strong need to encourage other forms of incentives and training programmes that in turn can lead to the growth of other organisations and alternative employment or career pathways (Mehta et al., 2014; UNSGAB-WS, 2015). The IWQMS vision and principles (DWS, 2017b) emphasise the need for partnership and cooperation, with integrated approaches between government, private sector and civil society where responsibility and accountability is fairly shared for more effective and sustainable water quality management. This in turn offers a space for developing stronger social and values-based approaches to IWQM strategy and practice in South Africa, but as pointed out above, these should not be overshadowed by economic reductionism. Scholars such as Bourdieu (1998) emphasize the role of cultural capital and social structures in shaping economic outcomes. They argue that economic reductionism overlooks *the interplay between social and economic factors, leading to an incomplete understanding of social phenomena.*

Considering diversities is increasingly important if one is focusing on community participation in IQWM, not least because this has the potential to enhance public or community participation – as shown in an ongoing WRC review on scaling of community-based water quality monitoring in South

¹⁰ In short, blue-, green- and no-drop accreditation refers to a system or process of accrediting or certifying organizations, facilities, or practices based on their water management and conservation efforts. These accreditation programs were initiated by the Department of Water Affairs and Sanitation (DWS) to ensure the provision of safe and reliable water services to the public. 1) **Blue Drop** for Drinking Water Quality Management Regulation aimed to evaluate the effectiveness of water service providers in voluntary monitoring, managing, and maintaining the quality of drinking water supplied to consumers, with those demonstrating excellent performance in water quality management being awarded Blue Drop status, signifying their commitment to providing safe drinking water. 2) **Green Drop** for Wastewater Quality Management Regulation was designed to assess the management of wastewater treatment plants and the overall voluntary performance of water services providers in terms of wastewater treatment and disposal. Water services providers that demonstrated effective wastewater treatment and environmentally responsible practices received the Green Drop status, indicating their dedication to sustainable wastewater management. The **No Drop** Status was a special recognition for water municipalities or facilities that scored high marks in both the Blue Drop and Green Drop assessments. Essentially, a facility with the No Drop Status demonstrated excellence in both drinking water quality management and wastewater treatment practices, showcasing an integrated and comprehensive approach to water resource management (<https://www.gov.za/speeches/water-and-sanitation-reinstates-blue-and-green-drop-programmes-7-jul-2021-0000>)

Africa that I have been contributing to (Lotz-Sisitka et al., 2022, see Chapter 4). Understanding diversity in IQWM can create a platform for different forms of participation to emerge, which ultimately can also bring different lenses to the problem. For instance, young people may not always be interested in participation that is conversational or inclusive as per Arnstein's theory (1969). Instead, they may want to be empowered through skills and competencies acquired through citizen science practice that are linked to career pathways, to decent jobs, entrepreneurship, etc. (UNSGAB-WS, 2015). They may also be interested in aligning their skills to any bursaries available to further their studies. For example, there is potential when one looks at expanding the learning academy proposed by DWS for graduate trainees to include those who may not qualify for conventional higher education institutions due to socio-economic ills (Department of Water and Sanitation, 2017d). In other words, it is also important to understand the diverse motives and interests of people who are willing to engage in community-based water quality management approaches within IWQM aspirations for participation. All of the above provide further background to the hydro-sociology and hydro-hegemonies of citizen science practice and the uptake and use of CS tools.

1.5.2. Structure 2: Water Research Commission (WRC)

The Water Research Commission is a research institution that was established under the apartheid state by water users in terms of the Water Research Act (Act No 34 of 1971) (*Water Research Act*, 1971) following a period of serious water shortages. The intention was to proactively develop knowledge of water issues and management in South Africa, as it was already understood then that water would be a limiting factor to South Africa's development in the 21st century. The WRC was established to help set strategic directions for SA's water sector and to coordinate research in critical areas. Initially, WRC research benefitted mainly the dominantly white, water-user community and the state, mining and agricultural industries, with research that had a strong engineering emphasis and culture (WRC & DWS, 2012). To create a more 'inclusive' impact and facilitate expansion of knowledge following the 1994 democratic dispensation, the WRC has partnered with different organisations, locally and internationally, and has broadened its research focus to include a stronger social and transdisciplinary dimension. Among other mandates, it aims to support the innovation value chain that directly empowers communities (ibid.), including the implementation of water quality management practices. The WRC has a mandate in the IWQM policy to extend research into community-based water quality management (DWS, 2017b), but currently it can only fund research projects in partnership with formal organisations or institutions; it cannot roll out funding to individuals or informal groups. The IWQMS (DWS, 2017b) indicates that the WRC should investigate funding and incentivising practices that enhance effective IWQM, including citizen-based water quality management.

The WRC has the potential for creating effective platforms for inter-and transdisciplinary studies in the area of IWQM, especially considering the realisation (Funke et al., 2012) that water quality management cannot be solved by one discipline or one sector. Understanding it from the point of CMAs alone is also inadequate, and hence studies from multiple vantage points are needed. Over time the WRC has been increasing the number of studies that focus on the social and participatory dimensions of IWQM. For example, there have been studies by Lotz-Sisitka and Burt (2006), Wilson and Pereira (2012), Munnik et al. (2011), Munnik and Burt (2014), Graham and Taylor (2018) and the wider study on scaling of citizen science and community-based water quality monitoring that this PhD research is also associated with (Lotz-Sisitka et al., 2022).

As such, the WRC is playing a leading role in recognising and advancing citizen science work and is taking the practice of community-based water quality management seriously (e.g. mini-SASS¹¹ and mini-SASS app development – Graham and Taylor, 2018). This gives meaning to the IWQM policy statement that the WRC should strengthen Community Based Water Quality Management (CBWQM) in South Africa. Ongoing research in this area is exciting, including, for example, a recent call for the development of digital tools for supporting CBWQM practice (Lotz-Sisitka et al., 2022) which can help with strengthening data and information management and monitoring, as well as in creating a platform for appreciating other representations of data or information.

However, WRC capacity and influence is limited. While the WRC does substantive research on water quality management issues, it cannot translate the research work that is done into practice, or substantively support the uptake and use of this research. This is something which needs to be done by other state actors and partners in the IWQM value chain, mainly, but is not limited to DWS. However, this requires additional engagement between partners. If the partners are not already cohesively working together, the processes needed to translate research into practice could create impediments to research impact.

As I was conducting this study, I was also involved in performing some of the policy review work for the WRC project focussing on the scaling of community-based water quality management under the IWQM policy and strategy (Lotz-Sisitka et al., 2022). A key finding from this policy review that are relevant to the study include insights around unequal power relations in the water sector.

¹¹ Mini-SASS is a simple tool which can be used by anyone to monitor the health of a river (refer to Chapter 7, section 8.3 for more details about miniSASS).

Uneven histories of power and influence in water resources decision-making: As indicated earlier hydro-hegemony draws attention to power relations and especially implications for the most marginalised. Based on the WRC history of policies (1912-1998) (Uys, 2008), land ownership (primarily white owned land rights) had a significant influence in allowing individuals or groups to have access to participation in the decision-making around water issues (WRC & DWS, 2012), hence also the post 1994 interest in participation and democratising water use, even though difficulties have been experienced as indicated above. In support of this argument, literature on the theory of institutional origins, particularly in legal and political contexts, provide valuable insights into understanding the role of institutions in shaping water management practices and policies. Glaeser Glaeser, La Porta, Lopez-de-Silanes and Shleifer (2004) explore how institutions, including legal and political frameworks, influence economic development and governance outcomes. They argue that legal and political institutions play a crucial role in determining the effectiveness and efficiency of resource management, including water resources, as is the case in water governing institutions and how they have functioned in South Africa today.

Glaeser and Schleifer (2004) emphasize the importance of secure property rights, contract enforcement, and a stable legal framework in incentivizing investments in resource management and promoting sustainable practices. Glaeser et al. (2004) also highlight the significance of political institutions in influencing water management outcomes. They explore the relationship between political factors, such as the degree of democracy and the presence of corruption, and the quality of public governance. Their findings suggest that democratic institutions and low levels of corruption are associated with better water management and governance practices.

In the case of WRC policy beneficiaries, those who had more land ownership than those who did not, who had the power to influence the law or policies in their favour were mainly the beneficiaries of the institutional power of the WRC in the past. The move towards including more citizen science studies is a move to shift the historical power associated with this institutional history. To shift institutional structures takes time as historical practices become embedded and entrenched. For example, under apartheid, , people relied on the water courts to establish and declare their water rights. Although this control was abolished from the water courts by the Constitution and the NWA in 1998, this aspect still has an influence on how participation is valued in decision making on water quality management. Much therefore still needs to be done to equalise power relations in the water sector, with the work

on citizen science being an important step forward within the wider intentions of the IWQM policy structure, carefully interpreted as noted above.

The CBWQM scaling research report (Lotz-Sisitka et al., 2022) indicates some realistic and practical lessons to be learned about the policy context in South Africa, as follows:

1. One of the important lessons to be learned about policy in South Africa, is that policy intent does not automatically translate into practice, and that significant policy contradictions exist, and there is inadequate social guidance on how to resolve this.
2. Therefore, we need to give adequate attention to the **translation processes** in the policy-practice system.
3. Such translation processes need to focus in on working WITH the public, which requires a **transformative co-learning model**, recognition of community agency, but also and equally, state responsibility and agency for working with publics and communities (deliberative and engaged democracy). This constitutes **the wider social learning approach** that was brought into focus for the scaling mechanisms and pathways outlined for citizen sciences in South Africa (Lotz-Sisitka et al., 2022).

The policy review above therefore provides the wider context and motive for this study, as will be elaborated further below.

1.6. Study focus and problem statement

1.6.1. Study focus and case contexts

As indicated above, many policies in the water sector emphasise participation in integrated water quality management. They stress the need for **more involvement and participation of citizens in driving the agenda**. How this is envisioned or intended to happen in practice is not clear, mostly because the policies and strategies lack social process definition, especially in the context of the emerging, and at times struggling, democratic dispensation in South Africa after 1994. This is one of the main reasons why this study focused on small-scale qualitative enquiry to offer an in-depth evaluation of the potential of the uptake and use of citizen science tools as one of the mechanisms which claimed to facilitate participation and engagement in integrated water quality management, as per the IWQM (DWS, 2017b) policy. There is extensive literature (Cornwall & Jewkes, 1995; Chambers, 1997; Shiva 2005; Coburn, 2003; Gibson-Graham, 2006; West, Igoe, & Brockington, 2006) that support the argument that small-scale and in-depth studies are better able to access grassroots levels where citizens encounter critical issues, in this case related to water quality in their everyday lives. These studies are seen as valuable because their small scale does not undermine their complexity and

significance in socio-ecological, economic, or educational deliberations. This is a bottom-up approach which has the potential to place people and their interests, views, perceptions, learning and experiences at the centre, in order to establish who, and how and under what circumstances the use and uptake of citizen science tools can empower community members to engage in participation and co-management of the country's water resources – as envisaged by participatory clauses in the NWA of 1998, and subsequent water policy up to the IWQM policy, strategy and implementation plan of 2017 which foregrounds citizen engagement as noted in this extract from the policy: "Government, in partnership with the private sector and civil society, secures water that is fit for use, for all, forever!" (ibid., p. xii).

In addition to fostering civic participation, IWQM policy seeks to secure values embodying its efficacy, such as those listed below in Figure 1.4. These values facilitate social and learning reflexivity, and their reality surpasses the policy document, which is the main reason they became the centre of exploration in this study. By saying their reality surpasses the policy document implies that the actual implementation and outcomes go beyond what is stated or intended in the official policy document. It suggests that the real-life practices, experiences, and consequences associated with a policy or program are more complex, varied, or significant than what is outlined in the written policy document. Since, policy documents serve as guiding frameworks or blueprints for desired actions and outcomes. But, the realities on the ground, influenced by various contextual factors, individual interpretations, and unforeseen circumstances, often result in outcomes that differ from what was initially envisioned or prescribed in the policy document. This emphasizes the importance of acknowledging the divergence between policy intentions and actual implementation, and recognizing the need to consider the practical implications and unintended consequences of policies. It highlights the dynamic and evolving nature of policy implementation, where the complexities of real-world contexts and stakeholder interactions shape the outcomes, sometimes deviating from the original policy intentions. By acknowledging such unpredictability researchers and policymakers can better understand the gaps and challenges in policy implementation, identify areas for improvement or adjustment, and ensure that policies are more responsive to the complex realities on the ground.

Value system – justice, ethics, equity, integrity, fairness	• Coherent action without a value system is at risk of floundering in the face of demands from competing sectors and the challenges of corruption. The Bill of Rights and the Constitution provide clear value-based principles for action in implementing the IWQM policy.
Courage	• The courage to act decisively, to make mistakes and to learn, within a cycle of monitoring and review that is governed by a strategic adaptive management approach.
Communication and team work	• Recognition of an interconnected water system of which water quality is a part, supports the needs for transparent communication and the ability to work as a team across all sectors of government and with the private sector and civil society.
Competence	• There are many aspects to IWQM, including technical aspects and the need to manage complex systems, that require high levels of technical competence. The appointment of competent staff must be supported by capacity building programmes.
Empowerment	• Officials are empowered to act (that is, to use their courage and competence) where there is effective leadership.
Informed civilians	• Informed civilians are a key element of the effective delivery of integrated water quality management. The emergence of an informed civilian population requires investment in effective public information processes.
Responsibility and Accountability	• Responsible action emerges when there is competence, trust, and an active, shared, value system. Accountability arises from the willingness and transparency to take ownership of those actions.
Listening and learning	• Responsive implementation of the policy will require water quality managers to listen to water resource users and protectors, both individually and institutionally, and to be open to new learning and to be able to change approaches in the spirit of adaptive management.

Figure 1.4: Values underpinning the Integrated Water Quality Management Policy (DWS, 2017c, p. xii)

These values are underpinned by the principles outlined in Figure 1.5 which also emphasise public participation and a people-centric approach to IWQM.

- **Principle 1:** Government-wide integrated water quality management
- **Principle 2:** People-centric
- **Principle 3:** Subsidiarity and accountability
- **Principle 4:** Transboundary water quality management
- **Principle 5:** Partnerships
- **Principle 6:** Administrative fairness and implementability
- **Principle 7:** Adopt administrative penalties
- **Principle 8:** An integrated and adaptive approach
- **Principle 9:** Hierarchies for pollution management
- **Principle 10:** Promotion of Green/ecological Infrastructure restoration and rehabilitation
- **Principle 11:** Risk-based approach
- **Principle 12:** Water quality is a developmental issue
- **Principle 13:** Broadened funding mechanisms
- **Principle 14:** Polluter pays
- **Principle 15:** Informed public
- **Principle 16:** Data is a strategic asset
- **Principle 17:** Publicly available information

Figure 1.5: Summary of Integrated Water Quality Management Policy Principles (DWS, 2017c, p. xiii)

Not only do the principles embody values about democratic public participation, they are also anchored within governing principles in practice (refer to Figure 1.4. above). It is the same policy vision

that this study seeks to interrogate. Particularly, the IWQM Strategy, (DWS, 2017c) notes that the central value for the strategy is to foster:

water quality management that integrates diverse knowledge (s) and practices informed by and informing co-learning, co-creation and co-adaptation ... management that shares responsibility in the **ACTION** needed between broader government, the private sector and civil society. (DWS, 2017c, p.xi)

While civic society is recognised as an important actor in collaborative decision-making, it is not clear how this knowledge is translated into action to create effective participation. Thus, this study unpacks these knowledge(s) assumed to be in practice and investigates how they ‘really’ look in practice.

The IWQM Implementation Plan (DWS, 2017b) “articulates roles and responsibilities for implementing critical activities and resources and further provides the linkages and dependencies between these activities” assumed between the broader government, private agencies and civil society (DWS, 2017b, p. i). From page 23 through to page 30 (i.e. goal 1 – goal 5) of the implementation plan, out of 77 activities, 20 activities involve civic society (DWS, 2017b), but again what this involves is not specified.

In the study, I sought to work on two different contexts that helped me understand how and why the citizen science tools were taken up and used and how the uptake and use helped citizens participate and engage in water resource management in their contexts within the above-mentioned policy contexts. These two contexts are explained in more detail in Chapters 5 and 7 where I discuss the Mpophomeni enviro-champs and the Vaal-Triangle public primary school teachers contexts in greater detail. Below I simply offer a brief introduction to the two cases to contextualise the research questions.

A brief description of Mpophomeni enviro-champ case study

Citizen science tools were introduced as an integral part of an already existing programme, the uMngungundlovu District Municipality (under Pongola-Mtamvuna Catchment area) – Save The Dam project. The aim was to strengthen the programme by means of anchoring scientific evidence. The enviro-champs (champions for the environment) were selected in 2011 through the uMngeni Local Municipality (located in the uMngungundlovu District Municipality) as part of the uMngeni Ecological Infrastructure Partnership: Save Midmar Dam, in support of the Mpophomeni Sanitation Education Project (MSEP), which was a Dusi Umngeni Conservation Trust (DUCT) and Wildlife and Environment Society of South Africa (WESSA) water management project. The purpose of establishing these enviro-champs was **to create resilience and a ‘joint’ citizen participation mechanism that would empower the communities and improve service delivery** (Taylor & Taylor, 2016).

Mpophomeni is a township situated near Midmar Dam which relies on the dam to provide drinking water. The enviro-champs were trained to test water quality in the stream tributaries passing through the township feeding to the dam e.g. uMthunzima River. The enviro-champs constituted school children, unemployed youths, elders and adults who were breadwinners.

A brief description of the Vaal-Triangle public primary school teachers case study

Citizen science tools were introduced as an integral part of the already existing learning and teaching programme for six public primary schools in the Vaal-Triangle area – under the Vaal Major Catchment Area. These public primary schools are spread across the Vaal-Triangle area in Gauteng province in South Africa. The main dam for supplying potable water is the Vaal Dam. The introduction of the citizen science tools was intended to strengthen knowledge and learning around rivers and their catchments in subjects such as natural sciences, life sciences, and geography for CAPS Intermediate phase and CAPS Further Education and Training Phase (Grade 10). Here citizen science practice was designed to be conducted through fieldwork experience and collecting scientific evidence.

Awareness and introduction of the uptake and use of these tools took place at a different workshop (the ORASECOM12 workshop¹³) to the one with the Mpophomeni enviro-champs. The project with the teachers took place in 2012/13 and responded to government's '**save water and sanitation awareness**' campaign. The service provider was WESSA (and ORASECOM) on behalf of the South African Department of Water and Sanitation. The majority of the teachers were older than 50 years¹⁴ and they were all teaching in public township schools, with more than 35 learners per class, and minimal access to resources and water infrastructure.

As indicated in the introduction, **the study is constituted as a realist evaluation** (see also Chapter 2) **and the evaluation interests for both contexts are:**

¹² ORASECOM – Orange-Senqu River Commission is the institution responsible to manage the resources of the Orange-Senqu River basin, a transboundary resource shared by Botswana, Namibia, Lesotho and South Africa. (<https://orasecom.org/>)

¹³ The public broadcast of the detailed inception of the three-year programme is found in the Emfuleni Municipality External Newsletter, Voice of Emfuleni (October 2012) 'Turning water losses into money saved' by Stanley Gaba.

¹⁴ The age of the teachers can be pertinent to the awareness and introduction of the uptake of tools for several reasons. For instance, unlike younger 'digital natives', Lei (2009) highlights that they might not be familiar and comfortable with using technology; not exposed to technology in education; their recent professional development opportunities might not have focused on integrating technology into teaching; also they might find difficulty in adapting and willing to try new approaches; and if they do they might lack support. However, it is important to note that while age can be a factor, it is not the sole determinant of a teacher's awareness and adoption of educational tools.

- Evaluating the what, how, why and under what circumstances there was uptake and use of the citizen science tools at Mpophomeni community to describe and explain the processes and systemic aspects involved, and to inform future citizen science practice within the IWQM policy framework outlined above. Stakeholders in this study include the WRC and DWS as decision-makers and agenda developers, WESSA and GroundTruth as tool developers, local municipalities involved as agenda and decision implementers and Mpophomeni community as beneficiaries and agents of the intended change.
- Evaluating the what, how, why and under what circumstances there was uptake and use of citizen science tools in the Vaal-Triangle schools, in order to inform future citizen science practice within the IWQM policy framework outlined above. The water quality management issues at the Vaal-Triangle primary schools were stratified because of their rootedness in the bureaucratic structures of state governance. There were different levels and types of stakeholders involved, e.g. the municipality, Metsi-a-Lekoa, school level actors such as teachers and children. Each group had different values which were not always complementary.

1.6.2. Problem statement and research questions

From initial data collected through GroundTruth, it was evident that water quality management problems continue to happen, even when there are systems put in place by governments and/or associates to control or mitigate the situation. The problem with these systems was that most of them require high levels of scientific skill and specialised knowledge (e.g. SASS4) and were expensive to access. Another worrying problem was that the tools for managing water quality were kept within structures/institutions. This raised concerns related to public access and utilization of the tools, and thus also questions of public participation, as lack of access to tools restricts the involvement of the public in decision-making processes and hampers their ability to address water quality issues effectively. Ribot (2004) further supports that it creates a power imbalance and reduces the opportunity for collaborative and inclusive approaches to water resource management.

An alternative approach involves promoting increased public access to these tools and resources. This requires addressing the lack of support from decision-makers and **completely decentralizing** control over the tools. By empowering the public with access to these tools and resources, decision-makers can foster more participatory and inclusive processes, enhancing the collective capacity to address water quality challenges as is the stated intention in the IQWM, notwithstanding its internal contradictions outlined above. This approach acknowledges the importance of democratizing access to resources and knowledge, ensuring that decision-making is not monopolized by a few institutions

or stakeholders. I intentionally state complete decentralization of the tools because Ribot (2004) argues that *incomplete* decentralizations “can increase vulnerability of local people when management burdens are transferred without resources” (pg. 2) and the mobilization of local people can end up being seen as mere labour rather than empowering them (pg. 2).

Therefore, the issue of the types of tools available (i.e. their design for accessibility) and where the tools are kept refers to the location of control and access. It is not about the specific structures or institutions holding the tools, but the concern also lies in the limited access and support provided to the public, irrespective of the entities involved to those tools that are accessible. To facilitate increased public access, the tools could be stored and made accessible through various mechanisms. These could include online platforms, community-based resource centers, open data repositories, or participatory decision-making platforms. The decentralization of resources would distribute the authority and control over water quality management tools, enabling broader access and promoting collective engagement. The issue of access to resources and their decentralization emphasizes the importance of equitable distribution, participation, and empowerment. It is an argument for the democratization of resource access, challenging hierarchical power structures and advocating for inclusive decision-making processes that involve diverse stakeholders, including the public. Decentralization of resources aims to distribute control, knowledge, and decision-making authority to enhance collective agency and promote sustainable and inclusive environmental governance (Armitage, 2005; Ribot, 2004). It also involves knowledge and practical training support for uptake and use of the tools, as highlighted in the IWQM Strategy (DWS 2017b).

However, as shown in the WRC CBWQM Scaling study (Lotz-Sisitka, 2022) there remains very little support, if any, from decision-makers for this practice. This then results in limiting public access and use of the tools whenever they might be needed. Subsequently, citizens become discouraged to learn, participate and engage in the decision-making on water quality monitoring and management. Moreover, there is little information known about how and why and to what extent citizens should participate and engage in water quality management, as this remains under-specified in policy, strategy and implementation planning as outlined above (DWS 2017a, b and c). By taking a bottom-up approach to this matter through the uptake and use of CS tools, it is hoped that this can provide insight into these gaps, and means/mechanisms for improving more engaged and effective water quality management through citizen science practice.

With this in mind, this study set out to investigate and explain the mechanisms, processes and systemic aspects involved in the uptake and use of citizen science tools. The study further sought to

establish enabling or constraining factors at play, as these may provide useful and meaningful feedback to citizen science practitioners and stakeholders involved in the monitoring and management of water quality in IWQM.

The aspects of the realist evaluation that this study explored in relation to the initial research done with GroundTruth involved tracing:

1. Who was involved in the uptake and use of the citizen science tools and why? (e.g. value, interest and benefit) at the time of the introduction of tools, during the use, and continued involvement. What issues arose, and who should be involved for change/improvement to happen? And what were the relations between them?
2. What citizen science tools were available and which ones were regarded as ‘generalisations’ for application into diverse contexts? And why?
3. What generative mechanisms¹⁵ were mobilised and used by the citizens in the uptake and use of the citizen science tools, to reach what outcomes? This includes mechanisms which can be ‘retroduced’ (their existence are inferred), ‘intransitive’ (they exist whether or not they are detected or activated) and ‘transfactual’ (they are enduring not transitory) (Scambler, 2012) (see Chapter 2 for more on this).
4. And how did the context influence uptake and use? To what end and effect?
5. How did the intervention process enable or constrain the uptake and use of citizen science tools for what purpose for whom and why? To what end and effect?
6. How has the uptake and use of the citizen science tools enabled or constrained participation and engagement? What form of participation? To what end and effect?

These constitute the main research questions of this study.

1.7 Conclusion

This chapter introduced the study, and offered a conceptual focus on public participation in the science-policy-practice nexus, arguing that this is required if policy intentions towards public participation in Integrated Water Quality Management are to be fully realised in South Africa as

¹⁵ Generative mechanisms here refers to Bhaskar’s explanation in Critical Realism. Bhaskar explains generative mechanisms as the underlying forces or processes that operate within social systems and contribute to the emergence of certain patterns, structures, or behaviors. These mechanisms are often hidden or not directly observable, but they are considered to be responsible for generating the observed outcomes. the aim to uncover the deeper causal explanations and structures that shape social reality. It goes beyond mere observation of surface-level phenomena and seeks to identify the underlying processes and mechanisms that produce and sustain those phenomena.

envisaged by democratic policy making in post-apartheid South Africa. The chapter argued towards the study rationale and questions.

In the next chapters I expand the enquiry, with Chapter 2 covering the theoretical framework of the study, Chapter 3 elaborating concepts significant to the study and Chapter 4 elaborating the methodology. Chapter 5 and 6 provide the empirical findings related to the CMO: Context (Chapter 5) and Mechanism – Outcome (Chapter 6) configurations in the Vaal Triangle Schools, and the CMO: Context (Chapter 7) and Mechanism- Outcome configurations in the Mpophomeni enviro-champs cases. Chapter 9 and 10 conclude the study, discussing the findings across the cases (Chapter 9) and providing with recommendations (Chapter 10).

CHAPTER 2

THEORETICAL FRAMEWORK: A REALIST APPROACH TO EVALUATION

2.1. Introduction

As indicated in Chapter 1, this study seeks an in-depth understanding and an evaluative perspective on citizen science practice, with specific reference to the uptake and use of citizen science tools at the interface between public citizens policy and natural science (point **A** in Figure 1.2). The study is constituted as a case study of the uptake and use of citizen science tools generated by GroundTruth, specifically for this study.

Documentation related to GroundTruth's practice for this project (Graham, Taylor, Pesanayi & Bruton, 2014; Graham, Taylor, Ward, Bruton, et al., 2014) reveals that the general context of the GroundTruth project where the uptake and use of the citizen science tools practice was carried out, has the following assumptions:

1. that adoption of this practice will empower '*citizens to make informed decisions for a better public participation and engagement*',
2. that the practice would potentially sustain itself through '*volunteerism*',
3. that the motivation force for participation serves '*learning beyond self-interest to also serve learning interests for the benefits of others and the environment*'.

The overall assumption is that the practice would ultimately teach or make the citizens as a collective aware of the science involved in whatever course of interest in this citizen science project (Graham, Taylor, Ward, Bruton, et al., 2014).

From GroundTruth's point of view, the aim of the project was to see how the intervention or programme had been taken up and to explore the outcomes. GroundTruth also sought to see if the uptake of citizen science tools should be mainstreamed because of their potential for allowing the community to work together to monitor and improve water quality management. Since the citizen science tools in this study were taken up and used in two different study sites i.e. the Vaal-Triangle primary school teachers and the Mpophomeni enviro-champs, the underlying model or theory that needed to respond to the research questions of the study had to consider the different contexts and the intentions or value of the intervention or programme and complexities mentioned above.

A **social theory** was needed for understanding social change that might/might not be emerging from the uptake and use of citizen science tools via **social learning, informal citizen science practices** and the forms of **public or community participation** these implied (cf. Chapter 1), as envisaged by GroundTruth. The purpose was to trace how citizen science programmes and practice can assist or alternatively hinder/have no impact upon evidence-based water quality management and improved social policies, as discussed in Chapter 1, looking at how these could in turn be potentially contributing to communities' quality of life. The main purpose of emphasizing social change was not meant to ignore these points:

- Concerns from natural sciences about whether using citizen science helps improve the confidence in data quality by reaching more diverse geographic areas.
- Academic studies looking into how citizen science, through data collection and case studies, contributes to advancing scientific knowledge.
- Rather, the emphasis on a social science focus aimed to examine the interface between the technical approaches of natural scientists and the social science explanations of citizen science practice, while also examining other circumstances that may shape or influence citizen science practices.

Therefore, there was a need for incorporating **in-depth qualitative data** from the participants' point of view, that would help capture how they narrate their life experiences regarding their relationship with natural resources like water. This data needed to uncover what participants thought/felt about water quality and water management, and why and how interventions via citizen science practices or programmes may have possible impacts on the quality of life aspired to by participants. This focus needed to go beyond looking into how the programme might enable citizens to acquire a better quality of life as aspired to by the programme designers. Different power dynamics are at play: between citizens, science and decision-makers (i.e. public, science and policy). In considering a democratic transformative social view within these contexts, this chapter explores global theories that can assist in explaining the complexity and in-depth design of the uptake and use of citizen science tools like those in this study.

As the study progressed, it became increasingly evident that disentangling the influence of natural science discourse on the adoption and utilization of citizen science tools, as well as their potential economic benefits and contributions to academic research, was a challenging task. This difficulty arises due to the deep entrenchment of these influences within the contextual fabric. Consequently, the benefits and challenges associated with these influences are intrinsically interconnected and

intertwined, making it difficult to examine them in isolation. The study revealed the inherent complexity and interrelatedness of these factors, highlighting the need for a holistic understanding of their combined effects.

It seemed therefore that the most appropriate approach would be an *evaluation study* that was *realistic* and that took adequate account of the *contexts of different levels*. The evaluation needed to be cognisant of the contextually complex realities that influenced the implementation of GroundTruth's citizen science programme with all its intentions, potentially also looking into any other similar kinds of studies. As shown in the two case study sites elaborated in Chapter 6 and Chapter 8 respectively, each context had its own dynamics that influenced the uptake and use of citizen science tools, which therefore needed to be carefully considered in the evaluation research.

2.2. Why realist evaluation research?

There is a long history of evaluation research, which evaluation authors Pawson and Tilley (1997) reviewed in depth. In brief, they mapped the field of evaluation research as moving from positivist correlational evaluations (1st generation), to quasi-experimental (2nd generation), and illuminative and more qualitative evaluation research designs. The latter fall into the hermeneutic and constructivist research traditions, where meaning-making of the participants in the evaluations were privileged firstly via a process of illuminating or revealing the situation (3rd generation), followed by a process of deliberative consultative co-construction of understandings of the situation (constructivist/naturalistic, 4th generation).

Following critiques of earlier positivism and postmodern forms of relativism in the strong constructivist tradition, these earlier evaluation designs were replaced by realistic social science evaluation designs that take stronger account of context and the underlying mechanisms that shape programmes, their theories and their emergence. Unlike other evaluation approaches, realistic evaluation does not require a researcher or evaluator to take sides or make judgements (Pawson & Tilley, 1997). They argue that realistic evaluation does not require researchers or evaluators to adopt a subjective stance or make value judgments about the intervention being studied. Instead, it encourages researchers to focus on identifying and understanding the causal mechanisms at play and how they interact with the contextual factors. The emphasis is on providing an objective analysis of how and why an intervention produces certain outcomes, rather than imposing personal opinions or taking sides. By adopting this stance, researchers can maintain a rigorous and systematic approach to

evaluation, focusing on the evidence and analysis rather than subjective biases. It allows for a more objective understanding of the intervention's effectiveness and provides insights into how it can be improved or adapted in different contexts.

Therefore, the data and context-mechanism-outcome (CMO) configurations provide guidance on what story to tell for what purpose. Thus, articulating one's 'theory of change' in relation to a particular project and its context has become popular in evaluation research as a means of probing assumptions underpinning projects more critically, and thus framing what needs to be evaluated at another level.

Importantly for this study, Pawson and Tilley's (2001a) approach to evaluation offers a methodological approach for developing context-mechanism-outcome (CMO) pattern configurations that allow researchers to understand 'what works for whom, in what circumstances, and why' (Tilley, 2000). This provides realist tools and approaches for probing assumptions and theories of change in more depth. Tilley (2000) noted that the realist(ic) evaluation method is a model of theory-driven evaluation¹⁶. It primarily focuses on locating what outcomes are generated from interventions, "how they are produced, and under what conditions a given measure will produce its impacts" (Tilley, 2000, p. 4). Therefore, the emphasis is on probing the contextual conditions that make the interventions effective or constrain their realisation. From this, one can develop lessons about how the interventions produce outcomes to inform further action or social policy development. Tilley (2000) proposed that there are three critical areas of research in realistic evaluation:

1. **Mechanism:** What is it about a measure which may lead it to a particular outcome in each context?
2. **Context:** What conditions are needed for a measure to trigger mechanisms to produce outcomes patterns?
3. **Outcomes pattern:** What are the practical effects produced by causal mechanisms being triggered in each context?

¹⁶ The interchangeable use of "realistic evaluation" and "realist evaluation" in this study is attributed to a historical development in the field of evaluation research, specifically in the work of Ray Pawson and Nick Tilley. Originally, Ray Pawson introduced the concept of "realistic evaluation" in the early 1990s as an approach to evaluation research. Realistic evaluation is a theory-driven evaluation approach that seeks to understand not only whether an intervention works but also under what circumstances and for whom. It emphasizes the importance of underlying program theories and mechanisms that link interventions to outcomes in specific contexts. Subsequently, Nick Tilley, who collaborated with Ray Pawson, used the term "realist evaluation" to refer to a similar approach with the same theoretical underpinnings. While the ideas and principles remained consistent, the name "realist evaluation" gained prominence and became more widely used. Over time, both terms, "realistic evaluation" and "realist evaluation," have been used interchangeably by scholars and researchers in the field. This interchangeability may be due to the evolution of the terminology and its adoption within different academic circles. It is important to note that regardless of the terminology used, the core principles and concepts of the approach remain the same. Both "realistic evaluation" and "realist evaluation" pertain to the study of causation in complex interventions, focusing on understanding the mechanisms that produce outcomes in real-world settings.

4. **CMO changes:** How are changes in regularities (outcomes) produced by measures introduced to modify the context and balance of mechanisms triggered? (Tilley, 2000, p. 145)

The realistic evaluation model and the Context-Mechanism-Outcome configuration and the associated research framework outlined above by Pawson and Tilley (1997), Tilley (2000), and Pawson (2002) was found useful for this study because it is a *realist evaluation tool* and acknowledges *complexity* of the context mentioned earlier. I applied Pawson and Tilley's (2004) framework to further develop the research focus of this study in this way:

1. **Mechanism:** What were the generative mechanisms? What was it about the uptake and use of the citizen science tools which may lead to a given outcome pattern in a given context?
2. **Context:** What structural, social, economic and political conditions were prevailing and were needed for the uptake and use of the citizen science tools to trigger mechanisms to produce given outcome patterns?
3. **Outcome pattern:** What were the practical effects produced by 'generative' mechanisms being triggered in each context? and
4. **CMO changes:** How were changes in outcomes produced by the uptake and use of the citizen science tools introduced to modify the context and balance of mechanisms triggered?

Important to realist evaluation research is the process of developing the context-mechanism-outcome *pattern configuration*. As stated by Tilley (2000, p. 104):

Realism provided the necessary ingredients for such a model: specification of the crucial contextual conditions for the intervention, the change-inducing mechanisms that will be triggered by the intervention, and the anticipated outcomes pattern that will be generated by triggering these mechanisms. This comprises a 'context mechanism outcome' pattern configuration.

Identifying these CMO pattern configurations allows the researcher to apply the lessons generated from one evaluation to a range of different contexts. The CMOs can then also be tested across a range of different contexts. In the case of my study, this would allow testing of the CMO configurations in other citizen science contexts and within the wider transboundary research area of interest in the WRC research programme being implemented by GroundTruth.

The ultimate aim of realist evaluation is, therefore, is to **test mechanisms of change uncovered, piece-by-piece**¹⁷, via evaluation work focusing on specific issues in programmes, so that these can further specific learning and change processes; in this case this was improved uptake and use of citizen science tools. Dealing with carefully constituted piecemeal analysis of CMO pattern configurations in a small-scale intervention, unlike a utopian or a more holistic approach of a specific social change for a specific issue, can, to some extent, enable decision-makers to make informed judgements about the direction of the programme earlier (Tilley, 2000). Hence, this method can be useful to policy makers mainly because of its potential for increasing the efficacy of the outcomes and strengthening the justification of policy implementation by doing the following:

- (a) in most cases the processes of policy making and implementation or practice take longer than the processes of policy evaluation (Pawson & Tilley, 1997) – this model allows for examining the efficacy of the programme from the beginning;
- (b) sometimes procurement of evaluation research is put at the end of the intervention or end of policy implementation (Pawson, 2002) – when put at the end it might be too late to make any valuable changes to the programme; and
- (c) lastly, in many cases, policy-making processes or interventions do not have a chance to engage with trial and error learning to refine themselves (Tilley, 2000) for more efficient implementation.

As such, this model, when applied from the planning phase, allows organisations to do the most with little or to unpack a lot of meaningful mechanisms in a limited time. This can help in re-configuring the intervention earlier to serve its intended purpose or develop meaningful results. Because of its multifaceted objects and subjects, this study seeks to generate knowledge of structures, cultures and agency mechanisms as these operate in different contexts, and how these lead to outcomes that may enhance socio-ecological policies for different contexts (as described in Chapter 1) as these relate to water management, via examination of citizen science practice and the use and uptake of citizen science tools.

2.3. Expansion, in depth and breadth of the CMO configuration in realist research

¹⁷ Test mechanisms of change piece-by-piece refers to an approach in which interventions or strategies aimed at bringing about change are systematically examined and evaluated by breaking them down into individual components or elements. Each component is then tested separately to understand its effectiveness and contribution to the overall desired change. This process allows for a more detailed analysis of how different elements of an intervention or strategy work together or independently to bring about the desired outcome, providing insights into the specific mechanisms driving the change process.

Table 2.1: Expansion of the formula of CMO configuration in time and according to different authors (elaborated and adapted from Marchal et al. (2010) and Mukumbang et al. (2019))

[Key: **C** – context, **M** – mechanism, **O** – outcome, **SCAR** – Structure, Culture, Agency and Relations, **Rn** – reason, **Re** – resource, **SEP** – structural emergent property, **PEP** – personal emergent property, **CEP** – cultural emergent property]

Authors	Formula
CMO configuration by Pawson and Tilley (1997)	C + M = O
Programme and implementation theory by Weiss (1997)	Mechanisms (the response that the activities generate) v/s successes and failures based on desired results
CMO configuration by De Souza (2013) CMO configuration by Archer (1995)	C + M (SCAR) = O Hidden (SEP) (PEP) and (CEP) = intentional and emergent outcomes
CMO configuration by Dalkin et al. (2015)	C + (Reason + Resource) = O
CMO configuration by Lacotour et al. (2015)	The vision = targeted causal mechanisms which are, according to these authors, close to the level of vision, theorised causal mechanisms (discourse) and observed mechanisms (arising out of practice)
CMO configuration by Porter (2015a)	Contextual Mechanisms + Programme Mechanisms + Agency = Outcome i.e. CM+PM+A = O Therefore, Programme (C + M (Rn + Re) + A = O) + Subjects (C + M (Rn + Re) + A (Collective/Individual) = O) + Issue (C + M (Rn + Re) + A = O) = O
Marchal et al. (2010) and Mukumbang et al. (2019)	intervention-context-actor-mechanism-outcome (ICAMO) configuration¹⁸
In addition to the above equations, the realist evaluator needs to consider the following: 1. That programme outcomes are also influenced by = S (internal programme activities + processes) + S (external activities + processes) 2. That programme developers' interpretation and explanation of meanings - The vision – <i>the target causal mechanism – preconceived methodology</i> - The misconceptions <i>Informal community-based volunteerism outside of structures</i> <i>Formal community-based volunteerism within structures.</i> - Integration – can be biased. - All doings and reasons have <i>history and inheritance</i> (human doings, thinking and interactions) of the predecessors and influence the outcomes and relationships	

¹⁸ I have taken Marchal et al. (2010) and Mukumbang et al. (2019) initial frameworks and modified them to align with the specific focus and context of the research in this Table.

3.	Subjects' interpretation
4.	The bigger picture: socio-economic and political view

Table 2.1. above demonstrates how the CMO configuration¹⁹ has advanced with time in the field of realistic evaluation, and how each phase has brought forth a unique aspect that was useful to this study.

Development of realistic evaluation and different aspects that each advancement brings forth, is explained in the Table 2.1 above. Realist philosophers Pawson and Tilley (2004) argued that social programmes²⁰ are shaped by a vision of change for social betterment. The notion of change (e.g. in the form of interventions) can either work or not depending on **the decisions or reasonings** made by actors in response to the intervention. The reasonings developed in this context are what causes the outcomes (Pawson & Tilley, 1997). They also argue that social “programmes are theory incarnate” (2004, p. 3). As such, evaluators' research **starts with a programme theory and ends with a more refined one**. The mechanisms here are the reasonings and decisions.

Weiss (1997) explained that “the theory-based evaluation examines conditions of programme implementation and mechanisms that mediate between processes and outcomes as a means to understand when and how programs work” (p. 1). In this case, Weiss (1993) added unpacking the social programme and its political context to the realistic evaluation. She argued that these two processes coincide in a social programme/intervention that the realistic evaluator needs to distinguish between. Firstly, there is the **implementation theory**. This is based on the notion that there are intended activities and desired effects (i.e. outputs) regarding how the programme is executed. The hypothesis here is that the programme's desired results are achieved if it goes as planned, i.e. programme success, and if it goes differently, this will result in programme failure. The second process is the **programmatic theory**. This “deals with the mechanisms that intervene between the delivery of the program service and the occurrence of outcomes of interest” (p. 46). This theory looks at the actor's response caused by the intervention. The “mechanism of change is not the program activities per se but the response the activities generate ... these mechanisms mediate between processes and outcomes” (p. 46). Hence, mechanisms, which are the decisions and reasonings explained by Pawson and Tilley (1997), are generated by both the implementation and programmatic theories.

19 Refer to Table 2.1 below: ‘Expansion of the formula of CMOs configuration according to different authors.’

20 Here programme means social programme or intervention.

In her 1993 article: 'Where Politics and Evaluation Research Meet', Weiss explained that this evaluation is “a rational enterprise taking place within a political context” (Weiss, 1993, p. 94). By political context, she meant three things: (i) the decisions made are always political, and its implementation is constantly under pressure due to the political processes involved, (ii) because it feeds into decision-making, its report enters the political arena. Thus, it is constantly in competition for attention with other social matters, and (iii) lastly, the evaluation itself has a political stance.

By its very nature, it makes implicit political statements about such issues as the problematic nature of some programs and the unchallengeability of others, the legitimacy of program goals and program strategies, the utility of strategies of incremental reform, and even the appropriate role of the social scientist in policy and program formation. (Weiss, 1992, p.94)

In Table 2.1 above, Weiss added the **complex layer brought in by the implementation and programmatic theories (i.e. internal activities and processes) within a political arena (i.e. external activities and processes) of programmes/interventions**. So, success and failure could be either from internal causes or external causes, or both. And this is based on desired results from external and internal forces (refer to the formula in Table 2.1).

Extending Pawson and Manzano-Santaella's (2012) realist diagnostic programme theory, De Souza (2013) further diagnosed potential weaknesses by focusing on the pre-existing social context of action (rather than social programmes) and their generative mechanisms (M) to improve interventions and social change needed in society. Her in-depth diagnosis and efforts pull out the influence of critical realism theory from Bhaskar's (1998) Transformational Model of Social Action (TMSA) and Archer's (1995) realist social theory: the morphogenetic approach (de Souza, 2013). She explained that some of these generative mechanisms (which are resources (R) offered by the intervention) and how they influence the reasoning of the participants (Dalkin et al., 2015) are hidden (but real) within structure (S), culture (C), agency (A) and relations (R). Hence the formula C + M (SCAR) (Table 2.1). Thus, a realist evaluator must consider confronting and unpacking hidden levels/concepts embedded within SCAR as enabling/constraining mechanisms in a programme because they influence the outcomes.

Lacotour et al. (2015) argued that categorising mechanisms as resources and reasoning, whether from the SCAR of the programme or not, is not enough, because the programme's operation does not depend on those mechanisms alone. Instead, they introduced and elaborated **the influence of the vision of the programme developers (or stakeholders)** in the programme, drawing definitions from Marchal et al. (2010) and Ridde and Guichard (2011). By vision, they mean differentiating between (i) what the stakeholders want, i.e. the targeted causal mechanisms (usually found in document analysis process), (ii) what the stakeholders say, i.e. theorised causal mechanisms (usually found in

interviews) and (iii) what the stakeholders do, i.e. observed mechanisms (usually found in the observation of the practice). The three influence the outcomes and effectiveness or not of a programme. Porter (2015a) further added the element of agency – objective structures (theoretically informed agency and human agency) to fully describe the social causation.

While some authors are interested in investigating how programme theory works in realist evaluation, and how it influences agency in social change, Mukumbang et al. (2019) focused on how the **realist interviewing technique**, as a mechanism and a content of the practice, can enable (or not enable) the outcomes of interest and promote systemic theoretical awareness. They considered how the realist evaluator optimises the realist qualitative interview technique to build and refine realist evaluation theory (Mukumbang et al., 2019). They argued that the formula $C+M=O$ by Pawson and Tilley (1997) must include the component Intervention and Actors (Mukumbang et al., 2019). This emanates from the fact that people are not passive recipients of interventions and “programs can only work when the relevant actors (A) adopt either all or parts of the intervention modalities (I)” (Mukumbang et al., 2019, p. 9). Hence the formula ICAMO.

De Souza (2013) drew on Archer’s (2000) work – which articulates structural, cultural and personal emergent properties at the level of the real as being foundational to the emergence of agency in social realist research – while also expanding upon the CMO model outlined by Pawson and Tilley (1997). De Souza’s (2013) elaboration of Pawson and Tilley’s work provides a more specified language of description and analysis for understanding mechanisms in realist research and how these mechanisms can influence the emergence of agency (e.g. the agency of the enviro-champs or the teachers in the citizen science projects). Moreover, critical realism acknowledges that agency is not a monolithic concept but encompasses different aspects and manifestations. Meaning there are many diverse ways in which individuals and social actors exercise their agency, factors such as intentions, motivations, reflexive engagement with social structures, and power dynamics. By unpacking them provides a more nuanced understanding of agency and its implications for the public participation in water quality management, aligning with how they interplay between structures, mechanisms, and human agency in social contexts.

This also assists realist researchers in exploring the processes at both the individual and collective level, and considering how these influence individual/collective agency, cultural agency, structural agency, and relational agency. Giving more attention to the small-scale and piecemeal mechanisms in evaluation research is important, because it is at this level that programme theory is or can be developed for transferring or generalising through a careful examination of specific components, processes, and contextual factors within a program. Blamey and Mackenzie (2007) highlight the

importance of unpacking the mechanisms at a micro-level, understanding the interplay between different elements, and identifying causal relationships. Similarly, Pawson and Tilley's work emphasizes the value of exploring the underlying mechanisms that generate specific outcomes, enabling a deeper understanding of how programs operate and how their effects can be replicated or adapted in different settings. Through a careful examination of these mechanisms, program theory can be developed, providing a conceptual framework for understanding how the program works and how its effects can be transferred or applied in different settings. This approach allows for a more nuanced understanding of program implementation and effectiveness, facilitating the transferability and generalizability of findings in evaluation research. The granularity of these mechanisms allows researchers to discern how specific causal relationships operate within different contexts. This, in turn, contributes to the development of robust program theories, which are crucial for the effective implementation and adaptation of interventions in diverse settings, such as this citizen science practice of this study. Failure to consider the above will leave the evaluation focusing mainly on implementation theory. Blamey and Mackenzie (2007) noted that in theory-driven evaluations, it is easy to focus on implementation theory rather than programme theory. They attributed the failure to get beyond implementation theory in most evaluations to be due to the emphasis placed on the "process of articulation relative to critiquing and testing" (p. 446) of assumptions. They also suggested that the complexity of context makes it difficult to uncover both implementation and programme theory; hence there is a need for an adequate language of description for uncovering programme theory. There is also a need for differentiating between implementation theory and programme theory. While implementation theory is concerned with the practicalities of implementing an intervention, program theory is more concerned with the conceptual understanding and theoretical basis of the intervention. Implementation theory addresses questions of "how" to effectively deliver and implement a program, while program theory addresses questions of 'how' and "why" the program is expected to produce certain outcomes based on its underlying logic and assumptions. In realist evaluation, implementation theory can be linked to uncovering generative mechanisms but should not be conflated with these.

Additionally, Blamey and Mackenzie (2007, p. 448) stated that "Realistic Evaluation approaches aim to constantly refine learning about which mechanisms are triggered in which circumstances for which individuals". They noted that knowledge should accumulate between evaluations, citing Pawson and Tilley (1997, p. 198): "Each evaluation should thus start with theory and end with more refined propositions for future testing with the goal being cumulatively to learn 'more and more about less and less'". Realists also have a generative approach to causation, hence the work of De Souza (2013)

was particularly useful, as it provides a language of description from social realism (Archers' emergent properties theory, 1995) that allows for theorising a generative causality in open systems.

I also drew on Chen's (2015) model of open systems because the environment of this study was open. One could say that all social research takes place in open systems, as argued by Archer (2000), De Souza (2013), Pawson and Tilley (1997), and Sayer (2000) – all of whom drew on Bhaskar (1997). By open environment, I mean that the input, transformation, and output mechanisms could come from anywhere at any time and interact in diverse ways; feedback might either bring about structural change or stability in uptake and use of citizen science tools. Pawson and Tilley (2004) argued that to explain change there is **a need to understand the pre-existing contexts and mechanisms** used, before introducing the citizen science tools. Pointing to depth analysis of mechanisms, Pawson and Tilley stated that **“it is not only about what mechanisms are there but also identifying where they are located (e.g. resources and reasoning)”** (2004, p. 7).

To further deepen the understanding of what mechanisms are, and to 'identify their locations', I used Bhaskar's (1998) ways of explaining knowledge of reality and causation as generative factors. According to Bhaskar (1975, 2008), knowledge of reality and causation or generative factors is structured, differentiated, stratified and changing. Bhaskar offered a stratified theory of reality which argues that reality exists in three interrelated domains which include: the **real** e.g. generative mechanisms, causes, and 'generative complexes' (meaning interacting generative mechanisms); the **actual** e.g. products, events; and the **empirical** e.g. observations, experiences, views. This study assumed that generative mechanisms caused events at the actual level and these events manifested at the empirical level in the use and uptake of citizen science tools. Not all these mechanisms were explicit; often they were hidden (Tilley, 2000). For instance, Tilley (2000) gave the analogy of things falling not being a case of seeing gravity at work, rather it is known that it is the causal mechanism that makes things fall. In this study, I also recognise that there is complexity at the level of the generative mechanisms themselves. One can also not assume that there is only one generative mechanism at work at a time; rather, generative mechanisms *interact* in generative 'complexes' (Archer, 2000; Bhaskar, 1998). Thus to explain the observed outcomes, there was a need to take careful account of the context in which the intervention/programme was introduced (Porter, 2015b).

Tilley (2000), quoting Popper, argued that this method can help us to understand the specific practical social problems in their realistic contexts and to measure their reduction. The method can be referred to as 'piecemeal social engineering' (p. 1), which has the potential to influence change and improvement in programmes.

2.3.1. Hidden Structural Emergent Properties (SEP), Personal Emergent Properties (PEP) and Cultural Emergent Properties (CEP) – Margaret Archer's morphogenesis approach as under-labourer for realist evaluation

In this study, I also included a focus on Archer's morphogenesis approach for two reasons. Firstly, its application is prominent in studies interested in understanding and analysing the processes of sociology/social sciences and education in complex social settings in time. These were centrally analytical constituents of the context of the uptake and use of citizen science tools project of this study. Archer's approach also has a complementary perspective to the realist evaluation or programme theory of Pawson and Tilley, as indicated above, and as articulated in the work of De Souza (2013). Like realist evaluation theory, **it considers and centres two constituents of social interaction and change which this study focuses on: namely the stratification and continuation of the interaction patterns between human agency (action/motives), and their influence on the pre-existence of structures (context) in time, shaping the future and metaphysical realm, vice versa and in cycles** before, during and after the intervention. The study focuses on the uniqueness of the interaction between structure, culture, and agency as different kinds of **emergent properties** that allow these interactions to function together. These sometimes hidden and unacknowledged cultures, structures, and personal emergent properties continuously influence human agency or action over time. They act as mediums and outcomes for the production, reproduction and transformation of "unintended consequences which form the context of subsequent interactions" (Archer, 1982, p. 456), which offers valuable lenses for this study and its system of practice – i.e. the uptake and use of citizen science tools.

These were used for analysis, shaping the findings of the study, and the discussion chapters of this study provide further insights into this interplay of SEPs, CEPs, PEPs (see Chapters 6, 8, 9 and 10). However, whilst working with the interplay of structure and agency, it was important to avoid interpreting this dualism at surface level (cf. King, 1999) as this might lead to poor or misinterpreted descriptions. Instead, it is essential to consider Archer's (2000) insight that understanding structure involves also understanding structural properties and powers, which in this study were explained at the level of the social mechanism of seeking **justice and its relationship to ethics** (Norrie, 2010). By justice, I mean questioning the interplay between **justice in terms of law** (e.g. rights, policies, value and/or utility, etc.), **justice at the level of freedom to express human agency/action** and **justice in terms of cultivating virtue/value** and their constraints (which I explain in more detail in Chapters 4 and 5) at both the collective and individual levels, both for the minority and majority groups. Analysis of the interplay of these justices provided the epicentre of understanding the morphogenesis

approach taken in this study. Therefore, a morphogenesis analysis, based on an inclusion of justice/ethics as an explanatory tool for emergent properties of structures, cultures and agency, provided meaning in this study to the depth analysis feature of Archer's (1982) reference. It argues the need to analytically separate and understands via analytical dualism that separates analytically structural, cultural and agentic emergent properties in our analysis in ways that differentiate "human history from human intentions, and the return of the consequences of that escape as causal influences upon human action, [because they are] a chronic feature of social life" (Archer, 1982, p. 456).

In combination with Pawson and Tilley's (1997) argument on the importance of identifying not only what mechanisms exist, but also where they are found and how they are shaped, the above views played a crucial role in this study. In this study, I focused on depth analysis of the mechanisms and the influence of hidden and unacknowledged structures (like justice/ethics), which were found to be influential in triggering both explicit and/or hidden mechanisms (e.g. resources and reasoning) that were also shaped by time (or history).

Triangulating²¹ both theories, that is Archer's (1995) morphogenesis approach and Pawson and Tilley's (1997) CMO configurations, provided an overall explanatory tool for **the practicality of explaining** the research question of the study: 'what works, for whom, under what circumstances and why?', in the field of social science and education and citizen sciences specifically. By practicality, I meant the form and functions of both theories as dynamic, reciprocal, and real when in practice or when at work, and how they influence and are influenced by practice – that is how the balance was kept and restored between theory and practice in this study's context.

2.4. Working with the limitations of realistic evaluation

Firstly, the study sought to take the position of interchanging the use of realistic or realist evaluation approach. The interchangeable use of "realistic evaluation" and "realist evaluation" is attributed to a historical development in the field of evaluation research, specifically in the work of Ray Pawson and Nick Tilley. Originally, Pawson and Tilley (1997) introduced the concept of "realistic evaluation" as an approach to evaluation research. Subsequently, in the 2000s they used the term "realist evaluation" to refer to a similar approach with the same theoretical underpinnings. While the ideas and principles remained consistent, the name "realist evaluation" gained prominence and became more widely used

21 Triangulation in this study is defined as a tool for expansion of understanding and knowledge about the issues under investigation (Yeasmin & Rahman, 2012).

(Tilley, 2004). Over time, both terms, "realistic evaluation" and "realist evaluation," have been used interchangeably by scholars and researchers in the field (ibid). This interchangeability may be due to the evolution of the terminology and its adoption within different academic circles. It is important to note that regardless of the terminology used, the core principles and concepts of the approach remain the same (ibid). Both "realistic evaluation" and "realist evaluation" pertain to the study of causation in complex interventions, focusing on understanding the mechanisms that produce outcomes in real-world settings. This study then uses both, on one hand because of its origins and on the other because of its evolution through other scholars mentioned in Table 2.1: Expansion of the formula of CMO configuration in time and according to different authors.

Thus, realistic or realist evaluation, like any other theory in social settings, has limitations. Therefore, the complexity of implementing/applying realist evaluation in this study was that the cases had different social settings (poverty being the common feature) that required different ways of implementation/ application. Even more complex, these social settings are natural social settings, and cannot therefore be 'aligned' or 'conditioned'. To be most effective, this evaluation theory therefore needed to provide for flexibility of application in different contexts, while also being able to adapt to evolutions in the settings as the agents and circumstances continued to evolve. In all social settings (such as those in focus in the two case study sites – see Chapters 5 and 7), social changes that occur in such settings are at times slow or rapid, visible or invisible, and it is not always possible for researchers to 'accurately' or fully detect them, especially when project interventions occur over a short period of time. The dynamic nature of the research setting is therefore also related to the reality that social change(s) (e.g. related to the uptake and use of citizen science tools) is itself a process, overlapping and evolving in relation to other processes occurring in society (e.g. curriculum change requirements or municipal infrastructure management events and processes).

The advantage of applying realist evaluation theory in both cases was that it is a theoretical tool that focuses on CMO configurations – in other words the dynamic nature of how context and mechanisms in a particular setting shape emerging outcomes – and it therefore has the ability to be applied in diverse and complex situations. Concentrating on the deep social mechanisms of seeking justice/ethics as a focus in this study's morphogenic analysis of the CMO configurations and how they play out (or not) allowed for the use of realist evaluation theory across the two diverse contexts. This was useful for probing and generating in-depth insight into the uptake and use of citizen science tools in the two contexts under study, making the chemistry between ethics (via the emphasis of the key

social mechanism of seeking justice, i.e. justice, in structural properties and powers in morphogenesis approach explained above), as well as triangulation of data and interviews, core functional features.

For example, in the case of the Vaal-Triangle primary school teachers (see Chapter 5 and 6), *the consideration of justice in time* as a key feature of the morphogenesis approach – the evaluation of social (educational) change in the uptake and use of citizen science tools – was daunting because it had to be *backtracked*. Hence, contextualising the participants' reasoning for how things were, and came to be in a new social setting, was difficult to do. However, these difficulties were bound to happen and there was no need to panic. As Tilley (2000) explained, experimentation in the natural sciences looks at observed patterns which are usually 'given' because of known underlying mechanisms, such as the law of gravity, magnetic fields, etc. In contrast, social science settings, even in settings for the simplest range of mechanisms and contexts, can be varied and unpredictable (ibid.).

2.5 Summary of Chapter 2

This chapter's main goal was to develop an overview of different aspects of the advancement of realist evaluation theory and CMO configuration, in collaboration with social change theories in order to develop a theoretical framework to guide analysis in the study. As can be seen from Table 2.1 above, there have been various iterations and refinements to Pawson and Tilley's original work on realist evaluation (1997), where they first put forward the CMO configuration as an approach to understanding what works for whom and why, under what conditions. In this study, I have expanded the CMO configuration work by adding Archer's morphogenic theory as it allows for deeper probing of social mechanisms, such as seeking justice and ethics, which were central to the interest of this study as will be described further in Chapters 6, 8 and 9.

In Chapter 3, the study explores the vision, contents, and concepts of hidden and emergent SCAR (reasoning and resource) mechanisms from the internal and external contexts of citizen science intervention of this study and from points of view of the intervention's developers and the project recipients.

CHAPTER 3

CONCEPTUAL FRAMEWORK – CONCEPTS INTEGRAL TO THE STUDY

3.1. Introduction

The previous chapter provided insight into the theoretical approach to the evaluation, but there is also a need to probe the nuances linked to the core concepts related to the study. These include citizen science, water as a common good, public participation and engagement (cf. also Chapter 1), the culture of volunteerism and sustainable development. These concepts are all integral to the purpose of the study and, importantly, help in *the uncovering of programme theory*.

3.2. Citizen science

The practice(s) of citizen science across different disciplines and countries shows that there are distinguished roles and powers assigned to citizens (amateurs) and scientists (professionals). At the same time, there are competitive views about balancing the values/powers between indigenous knowledge/existing community ecological knowledge and scientific knowledge (Pandya, 2012). These debates about different values assigned to different knowledges contribute to ethical issues. Especially since, as Mueller et al. (2010) have argued, citizens are willing to **commit to voluntary participation and engagement** because it allows them to make more informed decisions (Graham, Taylor, Ward, Pesanayi et al., 2014; Kullenberg & Kasperowski, 2016; Newman et al., 2017), think critically, collaborate with other stakeholders or create a network in the community of practice (Jordan et al., 2016).

In these processes of engagement, making a difference is dependent on how the citizens in citizen science programmes affirm a sense of place, identity and meaning, which will, in turn, determine their agency and advocacy (Jordan et al., 2016). It implies that a sustainable citizen science practice needs to be conducted with caution and care. It also involves understanding that the production of knowledge and the creation of environmental 'value' associated with the uptake and use of citizen science tools for decision making does not happen in isolation from 'other things' and different parallel knowledges that are affecting the users/citizens/stakeholders' development (Pandya, 2012). Pandya (2012) continued to argue that the uptake and use of citizen science tools should leverage diversity at all costs to prevent the science process from enhancing or exacerbating social inequality.

On the surface level, what is explicit in citizen science practice, such as those being examined in this study, is that there are different processes involved for effective and meaningful decision-making in

the citizen science project for change to happen which include: contribution, availability, access and use of the project design, data collection, data analysis, data interpretation, monitoring of data and **change-action** (e.g. Danielsen et al., 2009). What is interesting is that these processes rely on **public/stakeholder participation and engagement** as well as **volunteerism**. Furthermore, Danielsen et al. (2009) showed that the allocation of responsibility in each process involves differentiated and sometimes shared roles or powers (supported by Newman et al., 2017) between citizens and scientists. How that is shared, and at what level in the uptake and use of the citizen science tools, is of core interest in the evaluation being undertaken in this study.

The element of longevity or agility is unclear in citizen science projects (i.e. how long or how quickly) it takes for the desired change to happen. Little is known about the kind of influencers or agents of change involved for change to happen, or how structural, cultural and personal emergent properties influence the emergence of agency in citizen sciences projects (Ward, 2016). Vaughan (2007) mentioned that it is important to identify the stakeholders, but to know who matters or who does not matter in the construction of the concept of 'stakeholders' is dependent on many forces, including who the drivers are, what kind of collaboration is involved (Danielsen et al., 2009), what power relations are present, as well as the number of citizens mobilised (Woolley et al., 2016). This is amongst other possible factors on the ground, such as political and historical marginalisation, or even geographical factors, like distance from the water body, as became apparent in my study (see further elaborations in Chapters 6 and 8).

3.2.1. Power Dynamics in Citizen Science Interventions

Citizen science interventions have emerged as a novel approach to involve the public in scientific research and need to consider politics and policies that are relevant and radical. The presumptions in the practice is that the volunteers actively participate in data collection and analysis, thus facilitating a more inclusive and participatory approach to scientific inquiry. However, it is crucial to critically examine the power dynamics inherent in these initiatives and their broader implications.

This analysis is essential in order to understand how power imbalances may shape the design, implementation, and outcomes of citizen science projects. For example, the seminal work of Franz Fanon, particularly his book "The Wretched of the Earth", valuable insights were gained into the concept of power and its relevance within the context of citizen science interventions. As stated by Fanon, power dynamics are deeply intertwined with colonialism and oppression. Fanon argues that colonial societies are structured into compartments, with native quarters and European quarters, schools for natives and schools for Europeans (Fanon, 1963, p. 37), as fortified under law in apartheid

South Africa leaving histories of inequality and segregation as was also the case with water allocation and distribution as noted in Chapter 1. Drawing on Fanon's work allows for a deeper understanding of the underlying power structures and their psychological impact within citizen science initiatives. Furthermore, Fanon's analysis of colonial domination and its embedded nature in society, including in hydro-sociological relations, can help to illuminate how power relations may influence the goals and objectives of citizen science interventions in post-apartheid South Africa. According to Fanon, decolonization is a program of complete disorder and calls for radical change (Fanon, 1963, p. 36).

This highlights the disruptive potential of challenging existing power structures and norms within citizen science, reflecting the interests of hydro-hegemony studies as indicated in Chapter 1. Fanon's insights, help the study to critically explore how power imbalances manifest within citizen science projects, that is examining how power dynamics affect the design and implementation of the initiatives, as well as their outcomes and impact. Additionally, Fanon's work challenges both the researchers and volunteers to consider radical approaches that challenge systemic injustices and promote social change within the field of citizen science.

The work of Fanon sheds light on the historical origins of power imbalances within citizen science projects and emphasizes the need for decolonization and radical change in order to transform power dynamics and promote more equitable and inclusive practices within citizen science.

3.3. Water as a common good

Firstly, water is a vital common resource, and it is both a non-excludable²² and rival good²³ – this is at the epicentre of this study. Water system issues are in themselves transboundary and are never homogeneous or universal. Therefore, there are always different and sometimes competing visions and values attached to water informed by different schools of thought, whether anthropocentric or not. In South Africa, I refer to the National Water Act (1998) (see Chapter 1), which is used as a tool to regulate the imbalances of access, distribution and use between water users (Woodhouse, 2012) to centralise the common value of water. It is considered one of the most progressive pieces of water legislation in the world because it attempts to transform perceptions between stakeholders in water management by legislating participatory approaches to water management involving diverse stakeholders (Rose, 2005). However, the problem with the NWA is that it is still perceived as a tool that can only be used by the state via the previously known Department of Water Affairs now named

22 A good is non-excludable if many people can enjoy the benefits of the good whether they paid for it or not.

23 A good is a rival good if one person's use of the good diminishes or eliminates other people's enjoyment of the good.

the Department of Water and Sanitation (DWS) processes. So even when water pollution continues unabated (Abrams, 1996), the water resource management problem is always attributed to DWS (Rose, 2005) or 'water people within the municipality' (Metsi-a-Lekoa official, personal communication, September 20, 2016). Other departments do not find shared/common values in water management. Even more worrying, is that within any local municipality, water quality issues become the problem of a particular unit or group of people or team (Metsi-a-Lekoa official, personal communication, September 20, 2016). So, in this study, I intend to unpack the views of Emfuleni and Umngeni municipalities (within the water quality management department) on how, when and why water is perceived as a common good. I then evaluate the same concept amongst the citizen science tool users, developers and other stakeholders involved in the two different projects. This is to observe the following mechanisms: (i) how water quality can best be perceived as a common good to be managed harmoniously by both government and the public through the uptake and use of the citizen science tools; and (ii) how all stakeholders can develop or enhance collaborative and collective interest, value and benefit that is sustainable; and (iii) to see the kind of relationships between themselves specifically in the uptake and use of citizen science tools.

In the initial contextual data collected from Emfuleni municipality, Mpophomeni community and the primary school teachers (see Chapters 5 and 6), there was a concern around the potentiality and/or shortcomings of ubuntu or rather the cultures of ubuntu that were already present within water quality management. Ubuntu can be considered as an African philosophy for education (Lefa, 2015; Waghid, 2014), an African belief for an ethical and moral compass (Mbiti, 1969), an African view of life and if interrogated enough for socio-ecological relationships (i.e. by creating a liminal space) (Eliastam, 2015). It can guide the African renaissance, decolonial praxis and more transformative participatory engagements because of its "cultural capacity that expresses compassion, reciprocity, dignity, harmony and humanity in the interests of building and maintaining a community [and nature] with justice and mutual caring" (Lefa, 2015, p. 4). Therefore, I found it crucial to explore the concept of ubuntu, in particular, ubuntu as a pre-existing mechanism, also as a social identity artefact as it relates to water as a common good.

I was further interested to see if ubuntu related concepts/mechanisms could be a key to converting moral judgement and conduct into agency, action and advocacy that is sustainable and self-reliant in the uptake and use of the citizen science tools. Mawere (2014) demonstrated that ubuntu (and

ukama²⁴) (Le Grange, 2012a; Le Grange, 2012b; Murove, 2009) can be a driving agency for environmental conservation and management, even though this has not yet been recorded in the case of water quality management. This is in contrast to Levy's (2004) argument in his book *What makes us moral? Crossing the boundaries of Biology* where he stated that claiming ubuntu as the only moral or ethical motivation and agency that could be shared (e.g. in the uptake and use of citizen science tools) could be very naïve. Other factors, whether moral or ethical, need to be explored. Some of these dynamics were explored further in this study, which I elaborate conceptually further below.

3.4. The spirit of ubuntu as a pedagogical, ethical and moral mechanism for sustaining and improving water quality management through citizen science tools

In this section, I look more deeply into how the spirit of ubuntu can be strengthened to allow sustainable public participation and volunteerism for the common good, with a focus on the improvement of water quality management through the uptake and use of citizen science tools.

Ubuntu is a widely used concept to describe a relational ethic of care and mutuality in Africa, with roots in African culture and philosophy. Elistaam (2015, p. 2) quoting many authors, explained that there are varying interpretations of the core concept:

The principles of Ubuntu resonate with universal values of human worth and dignity. The late Archbishop Emeritus Desmond Tutu (1999:34-35) explains that the meaning of Ubuntu is that, 'a person is a person through other people. It is not "I think therefore I am". It says rather: "I am human because I belong". I participate, I share'. The concept highlights the interconnectedness of human society, with the implication that people should treat others as part of the extended human family. Ubuntu has been translated as 'humanity' (Shutte 2001:2), 'African humanness' (Broodryk 2002:13), 'humanism or humaneness' (Mnyaka & Motlhabi 2009:63), or 'the process of becoming an ethical human being' (Mkhize 2008:35). Prinsloo (1998:41-45) describes various understandings of Ubuntu in the South African context. Chikanda (1990) sees Ubuntu as African humanism. It involves sensitivity to the needs of others, charity, sympathy, care, respect, consideration and kindness. For Khoza (1994), Ubuntu is an African view of life and the world in which people share and treat each other as humans, based on an underlying 'universal brotherhood' of Africans. In Mkhize's (2008:43) understanding, ubuntu 'incorporates ideas of social justice, righteousness, care, empathy for others and respect'. Mnyaka and Motlhabi (2009:74) write that ubuntu 'is

24 Ukama means relatedness to the entire cosmos (Lesley Le Grange, 2012a).

inclusive ... it is best realized in deeds of kindness, compassion, caring, sharing, solidarity and sacrifice'.

My interest in this study is not to review or deliberate on all the meaning(s) of ubuntu, but rather to focus on the 'spirit of ubuntu' as elaborated below.

3.4.1. The origin of the spirit of ubuntu

The background to ubuntu and the kind of 'spirit of ubuntu' that this study seeks to explore and apply is evaluated and critiqued from its context of merit.

Given the historical assumptions surrounding volunteerism, particularly in relation to citizen science, it was crucial for this study to delve into the essence of ubuntu. The aim was to consider its efficacy and limitations when employed as an ethical and moral framework in pursuit of sustainable development goals and the principles of the common good through the utilization of citizen science tools.

When applying the spirit of ubuntu, it is important to carefully ensure that one does epistemic justice to it and that it is applied with sympathy. This is because the spirit of ubuntu as an ethical and moral approach is complex, which may also be why it is sometimes criticised for being vague in guiding citizenship education (Enslin & Horsthemke, 2004), and in its essence it may differ from how some Western theorists are superficially portraying it (Mbiti, 1969; Metz, 2011). There is cultural depth as well as breadth in time, space, scale, social context, and history associated with its methodology, analysis, interpretation and application that may need to be considered if one uses the concept. I elaborate on some of these dimensions below.

To start, I consider the spirit of ubuntu through a religious and philosophical lens via Mbiti's (1969) perspective in which he described the African²⁵ people(s) (to some extent referring to different cultures) where the term originated. There are lenses which have been used to look at the spirit of ubuntu, from a jurisprudence perspective (Mokgoro, 1998), and via socio-ecological (Mawere, 2012; Mawere, 2013), educational (Letseka, 2012; Letseka, 2014; Mpofu, 2002) and economic (Khomba, 2011) lenses. Thus, I will discuss their usefulness and support in this study later, particularly their relationality with respect to an intrinsic ethical value. These lenses are helpful and interdependent because improving water quality management through citizen science tools is complex and needs all the relationships involved to have a lasting, meaningful impact. However, my emphasis will be on

25 African here refers to those who originate from Africa.

discussing the potential (or not) of the spirit of ubuntu as an ethical and moral value in the socio-ecological and education arena.

I used Mbiti (1969) because he foregrounded the ideology and logic to approaching 'the spirit of ubuntu' with depth and breadth relevant to this study. I also discuss the shortcomings of the spirit of ubuntu and its unintentional implications in socio-ecological spaces which are particularly relevant to this study. I intentionally use the word 'spirit'²⁶ (Oppenheim, 2012, also mentions it), which is usually left out in many studies or philosophies considering ubuntu. This positioning gives more depth to ethics or moral considerations, rather than simply calling it ubuntu. It is a spirit because it is a 'soul' force (Gade, 2012) that continues to exist and be constantly effective through generation after generation, via human beings, nature/environment and spirits.

In his book *African Religions and Philosophy*, Mbiti (1969) started by emphasising that African people have always been religious people. By religions, Mbiti (1969) refers to 'engaging in' African traditions (i.e. languages, practices and beliefs), identities and knowledges that determine how people think, speak and act. He mentioned that African people carry these religions everywhere they go and in whatever role they play in communities and societies. Furthermore, he noted that even though these traditional religions may not be intact due to the influences of modernisation, this does not necessarily mean that they are extinct. It does mean, however, that in many cases African people express them during a crisis, and in some cases, they may not be observed because they are being expressed or performed in secret. This background of how these traditional religions are embedded in the African person is vital for this study in terms of understanding the African participants of the study and not assuming that they are simply empty objects without agency and intellect. It is also useful for avoiding the mentality of 'I, as a researcher, have come to teach them new things they need' and for decolonising the perception that the citizen science project intervention of this study is seen as a hero that has brought something to civilize or save the local community (Mbiti, 1969). It is also important to keep social learning in mind because this study is simply a catalyst through which all parties would be learning together and developing a collective agency for improved water quality management.

26 Spirit is referred to in the singular here but it is constitutive of spirits, the spirit of the humans, nature, of animals, the Spirit of God.

Mbiti (1969) went on to argue that traditional religions are not only for the individual but also for the community.²⁷ A human cannot detach themselves from the religion of their community and to become and belong to the community is to participate in the traditional religions and relationships that make up the community (Tutu, 2013). However, due to the influences of modernisation and urbanisation, it has been observed that individuals are driven towards detaching themselves from their communities. This is another aspect that needs to be considered when trying to understand the collective and individual agency required in citizen science projects of this kind. Mbiti (1969) went on to say that if the individual or the intervention is to make a sustainable impact upon the individuals and the community, then one needs to embrace their "language, thought patterns, fears, social relationships, attitudes, and philosophical disposition" (p. 3), to fully commune with them.

Even though this African philosophy may sound as if it does not support individualism, Mbiti argued that individuals have the autonomy to choose their practice, religious ideas, etc. They can even modify these according to their historical situation and needs. And because traditional religions are so embedded in their beings and doings – intergenerationally and in their individual journeys – there was no need to write them on paper or document them. Rather, they are written in the hearts, minds, oral histories, rituals and religious personages like priests, elders, rainmakers, etc. This is therefore a further element for this study to consider, that when we speak of care and respect of ethics and morality, one needs to understand the depth of what is involved. As Mbiti (1969) stated, "African people are motivated by what they believe and what they believe springs from what they do and experience ... thus belief and action cannot be separated" (p. 4). So, belief and action are what the African people bring to a table if any intervention intends to explore their capabilities that are accessible and usable via the African traditional religion for any activism they value.

Mbiti (1969) acknowledged that African societies, cultures and languages continue to evolve. It is this diversity and evolution that one needs to understand as part of the context in which African traditional religions and philosophy are applied. Hence, I need to understand the context in which I apply the spirit of ubuntu as an African traditional religion and philosophy. As Mbiti argued, to understand the way the spirit of ubuntu works in the contexts of the study, as an outsider I must acknowledge that 'I cannot enter or appreciate **fully** the traditional religion of another society' (p. 4) because observing and hearing how the participants experience life and practice the spirit of ubuntu does not mean I am converted or truly understand. Instead, I can only account for my truth of understanding. These are

27 Community: here Mbiti refers to the people (usually made of families – family is inclusive of extended relatives), environment and the spirits and God including those of the past, present and the future.

the depths of the spirit of ubuntu that many scholars misunderstand, misinterpret and misrepresent, especially when they overgeneralise the concept.

The aspects mentioned above about the depth and breadth of the constitution of African religion and philosophy dominate the background of the African people, the study participants in Mpophomeni and Vaal-Triangle included – meaning they form part of the participants' life worlds (refer to Chapters 5 and 7). In Chapters 6 and 8, it becomes clearer as to why and how these contexts form the basis of this debate. Importantly, I am not trying to argue that anyone born outside of an African origin cannot uphold the spirit of ubuntu, because everyone is capable of intentional, deliberate mindfulness and 'ethics of care'. However, if one is interested in relational ethics, it seems the Afro-communitarian morals or African ethics could add value and strength or could expand upon the notion of Western ethics of care because of their engrained concept of the community or collectiveness as a characteristic feature (Metz, 2013). This feature is one which is, or ought to potentially be, a fundamental feature of citizen science, the common good, public participation and engagement, as well as a component for achieving the Sustainable Development Goals. The aim is not to romanticise African ethics of care or ubuntu, but rather to probe its potential for common good practices such as citizen science intends.

In terms of the methodology of analysis of African traditional religion and philosophy, Mbiti (1969) mentioned that firstly, the interpretation of information at hand would not be completely free of subjectivity – as in any other theory or philosophy. At the time of his writing (1969), he argued that some African philosophical systems were not, as yet, appropriately formulated. One finds the spirit of Ubuntu is continuing to be interrogated in-depth, especially in sub-Saharan Africa. For example, in South Africa we have work by Metz (2016), Etieyibo (2017), Le Grange (2012b, 2018b) and Terblanché-Greeff (2019). Many writers/philosophers from Zimbabwe have considered these concepts, including Mawere (Munyaradzi Mawere, 2012), Chibvongodze (Chibvongodze, 2016) and (Chemhuru, 2019). There is also work in or about Lesotho (Mahlatsi, 2017); (Palframan, 2015) and in Kenya by the social philosopher Masolo (2019) that indicates that ubuntu, as African philosophy, belief, etc. for many aspects of life, is continuing to be refined, with related writings found in many books about religions, proverbs, oral traditions, ethics, morals, totems, politics/policies, social development, education, philosophy, etc. of the society concerned. This means that the understanding and application of the spirit of ubuntu is contextual, even though there are similarities from place to place. Mawere (2013) argued that these spaces of interpretation have been used as mechanisms for protecting, conserving

and respecting the environment (Chibvongodze, 2016; Chemhuru, 2019) (see also Chapters 7, 8 and 9).

So far, I have described the foundation of the spirit of ubuntu and its capabilities in an ideal world; in the next section, I discuss its shortfalls.

3.4.2. How then to apply and strengthen the spirit of ubuntu with care and respect that are of 'African nature'?

In this study I consider: Is the spirit of ubuntu outdated for socio-ecological and educational value? Has it been eroded? Does it foster anachronism? Is it inclusive of other cultures? Is ubuntu only for 'black' Africans?²⁸ These are the questions around whether the spirit of ubuntu still exists and, if so, in what way and where this might be so. Eliastam's (2015) paper 'Exploring Ubuntu discourse in South Africa: Loss, liminality and hope' has described some of the shortfalls, misunderstanding and misapplication of the spirit of ubuntu. He categorised ubuntu as one of the 'narratives of return'. Drawing on Tutu, he suggested that some aspects of ubuntu may have been lost or disrupted by coloniality and apartheid. However, his argument and the empirical data in his paper showed that despite these disruptions, people are still actively practising ubuntu. This offers hope for both relationship building coming out of such a history and for guiding patterns of daily living. It is helpful in responding to the layered ethical and moral investigation of this study about whether the spirit of ubuntu can be reinvigorated as an ethical approach to strengthening sustainable ways of improving water quality management through the uptake and use of citizen science tools. I consider ubuntu as an ethical approach that can embrace and support participants' identities without subjugating their sense of being and social context.

In his paper, Eliastam (2015) articulated a 'liminal space' noting that the spirit of ubuntu is a strong philosophy and ethical feature of life in Africa, but there are visible signs that it may have been disrupted to some extent by coloniality and apartheid. There is still, however, a solid commitment to ubuntu, which produces "hope for a healing of identity (which must underpin any reinvigoration of ubuntu), and there is hope for creating patterns of living which embody the notion of ubuntu in its most basic sense" (p. 7). Eliastam believed that this liminal space brings hope for kindness, sympathy, caring and compassion, treating others and the environment with respect, generosity with genuine humanity (Oppenheim, 2012), even though "the goal is personal fulfilment, selfishness is excluded" (Metz, 2011 quoting Shutte, author of *Ubuntu: An ethic for a new South Africa*, 2001). In response to

28 Here African refers to those who live in Africa and embrace and respect each other's cultures.

Eliastam's (2015) argument for a liminal space which offers hope for 'patterns of living which embody the notions of ubuntu', I draw on Oppenheim's (2012) argument that extends this liminal space such that this hope can be realised when everyone is taking responsibility and accountability:

The drive of the Ubuntu spirit is to become more fully, genuinely human, in unity with one's fellow man. The active nature of Ubuntu does not limit it to a static state, and the ability to gain Ubuntu lies in the centre of every human. Suppose all human individuals contain within them a common core of decency as described by Mandela. In that case, **every individual** must also have the ability to access this core and, if their heart is touched, they are capable of changing. (p. 371)

The above-mentioned quote is a core principle of the spirit of ubuntu (and the common good); it values the willingness, determination and capability of all human beings; hence it is a humanitarian and communitarian philosophy. This is particularly important if the aim is to take South Africa or Africa forward as a unit or community striving for the common good.

According to Metz (2011, p. 540), being part of the community means that "a human being lives a genuinely human way of life to the extent that she (he) prizes identity and solidarity with other human beings". And, according to Oppenheim (2012), "ubuntu's focus is on joining in harmony with one's community and becoming an active, direct, positive part of this whole" (p. 372), which aligns with **the deeper intentionality of citizen science in the context of water quality management in South Africa** – as introduced in Chapter 1. Importantly, having a spirit of ubuntu or imparting a spirit of ubuntu is not a responsibility of others or 'black' Africans only, but is rather an obligation for all living in South Africa, Africa and the world more widely. In the spirit of ubuntu, everyone plays a role in enabling themselves alone and enabling the community around them.

Metz (2011) went on to say,

Actions such as deception, coercion and exploitation fail to honour communal relationships in that the actor is distancing himself from the person acted upon, instead of enjoying a sense of togetherness; the actor is subordinating the other, as opposed to co-ordinating behaviour with her; the actor is failing to act for the good of the other, but rather for his own or someone else's interest; or the actor lacks positive attitudes toward the other's good, and is instead unconcerned or malevolent. (p. 27)

The values ingrained in the spirit of ubuntu are not of the past or anachronistic, but they are not immune to that conception. The spirit of ubuntu exists and is real (Bhaskar, 1998). What is of interest in this study, is its interpretation and application going forward within communities who are engaging with socio-ecological concerns such as water quality management and education in the context of the study sites. The study seeks to develop further insight into this area of concern (see research question 1) and to avoid exploitation, abuse and corruption of the spirit of ubuntu (Gade, 2012).

3.4.3. Ubuntu-ethics considerations for strengthening social and education value in citizen science research in the water sector

The ethical processes in the study were stratified, and included a consideration of ethical principles of relationality in society discussed above under the notions of the spirit of ubuntu and water as a common good, social-ecological ethics of care and concern which emerges in agency and volunteerism, ethical intentionality of the law as found in water policies and their implementation processes (e.g. the referent used by GroundTruth for the development of citizen science tools and practice), and the ethics or moral cultures informing participants, and ethics informing the profession of educators and environmental practitioners. Ethics are a cultural issue (Groenfeldt, 2019); hence it was vital to respect the cultural diversity embodied in the study with humility and objectivity (UNESCO, 2006) to allow a welcoming debate and opening up of ethical questions associated with the uptake and use of citizen science tools. These are discussed in this Chapter and reflected on in the final chapters of the study. In a separate but related way, the study also had to take research ethics and ethical research practices into account (discussed in Chapter 4).

3.4.3.1. Problematising water ethics in South Africa

Globally, water security and availability in many countries are becoming more and more threatened by many aspects besides climate change, including social, economic, political and environmental instabilities. Water sustainability is highly reliant on its management (Al-Weshah et al., 2016) that needs to take place at the meeting point of different disciplines and cultures. Working in this intersection can be tricky since each discipline has its own agenda and is governed by different ethics. However, what connects them is their focus on **preserving citizens' dignity** and **solidarity** through **water management as a common good** (Jennings et al., 2009). Also, they all have legal obligations for improving citizens' welfare and their living environments. All countries have signed up for regional and global commitments and treaties such as the SDGs.

At the same time, water as a common good connects people, non-human, countries, spheres of life, etc. Thus, the management decision needed calls for **common ethics and ethical practice (s)** informed by contextualised systematic thinking, reasoning, and a justified approach. This means there will be a

point of learning new things and unlearning old things informed by both top-down and bottom-up processes of (ethical) management (ibid.). But more so, it requires the bottom-up approach that centres public participation – **full participation** of all individuals, including those previously disadvantaged, to **influence** efficient local public service delivery decisions (Groenfeldt, 2019; Jennings et al., 2009). Full public participation through ethical practice means it is not only met through informing, consultation and deliberation – but also through fair partnership and delegated power between the citizens and power-holders (Arnstein, 1969b) as argued in Chapter 1.

As indicated in Chapter 1, the idea of public participation is observed in many water laws such as Integrated Water Quality Management Policy (IWQMP, 2017); National Water and Sanitation Master Plan (NW&SMP, 2018); National Water Act (1998) and involves community participation via Catchment Management Agencies; etc. However, what is **fair and ethical** in public participation has not been recognised or strengthened. Instead, there is a tendency in South African water governance to shift the blame to the laws or policies when things go wrong, with Muller (2018) indicating that the problem is not with the laws but with the people who ought to implement them. Muller (2018), in this regard, further argued that South Africa does not need new policies but rather it needs new (ethical) ways, rather than focusing on political ways of managing its waters. Hence the need to foster and empower effective and fair ethical public participation practice approaches in the management decisions. Thus, **social (i.e. education and cultures) and ecological ethics** come together in citizen science practice, especially when oriented towards sustainable development that aims to:

the needs of the present generation without compromising the ability of future generations to meet their own needs... sustainability extends justice into the future by bringing together social, ecological, and economic considerations. (Al-Weshah et al., 2016, pp. E175- E176)

Currently, South Africa has good water laws and policies (i.e. structures) that can enable these ethics as a cultural practice. However, these laws or policies do not foreground these ethics since these ethics in themselves are different from water laws. Al-Weshah et al. (2016) explained that ethics are above the law because it is not about what one knows (knowledge = laws) but rather about what one does (e.g. behaviour and attitude). And what one does is driven by an innate obligation constituting personalised knowledge and relationships, social responsibility and accountability that informs one's decisions on what to do (Al-Weshah et al., 2016; Mbiti, 1969).

Ethics are commonly associated with religion or vulnerable groups, e.g. children and women (Pillay, 2014). However, amongst the vulnerable groups, this study intends to focus on ethics linked specifically to disadvantaged and economically marginalised groups, e.g. members of the

Mpophomeni enviro-champs. That is the reason why the idea of water as a common good needs strengthening – because the common good is not only about what one knows, but it is mainly about what one does, which is pertinent to citizen science practice as people are involved in water quality monitoring for the common good.

The intent of bringing views on ethics and the spirit of ubuntu forward conceptually in this study, was to create a space in which it could be possible to recognise how ubuntu, seen from the participants' perspectives, can be an enabling mechanism that can strengthen research and interventions. Though ubuntu might not be the only current solution, its ability to condition policies and practices in the contexts in this study must not be taken for granted; hence it needs to be treated with sensitivity and we need to make efforts to be informed and critical (Tilley, 2000). It is these sensitive details of the study's contexts that ubuntu enables us to see and interrogate, as will be further elaborated in Chapters 5-10.

3.4.3.2 Problematising the culture gap between the institutional ethics and socio-cultural meanings and perceptions of ethics (Mokgoro, 1998)

In the domain of social ethics, questions of institutional and scientific knowledge about ethics are investigated in contrast with aspects of socio-cultural meaning and perception of ethics. The ethics applied by science and institutions tend to lean more towards the laws and policy frameworks and principles, whereas ethics applied by the communities often tend to lean more towards socio-cultural traditions and morals.

The topic of ethics in social, ecological and education research is sensitive and complex. As such, it is a topic that cannot always be preconceived; at the same time, it cannot be taken for granted. Ethics are negotiated between researchers, institutional representatives, participants in diverse contexts, and there is need to consider the changing relationships and dispositions of those involved. Power dynamics in these settings are also always in a continuum and in relational movement. Mokgoro (1998) alluded to this phenomenon saying that “one is constantly challenged by others, practically, to achieve self-fulfilment through a set of collective social ideals” (p. 3). He further explained that it could not be preconceived because “in one's own experience, Ubuntu [morals] it seems, is one of those things that you recognise when you see it” (Mokgoro, 1998, p. 2). It means every new participant and participation should be treated afresh ethically because they bring a different element of the relationship that ought to inform the ethics of a programme.

Another reason for examining the ethics concept more carefully is that the realist question of ‘who manages the water quality and how?’ is a question that cannot isolate agents from their structural

and cultural activities (whether organised or not) and agency. They are also governed by varied ethical protocols and moral principles, which they reflexively navigate on a daily basis in their contexts.

This study sought to understand ethics and moral principles that foster unity and fairness for social change through the uptake and use of citizen science tools. Fortunately, in South Africa and some parts of Africa, such principles and structures can be found within the jurisprudence system (e.g. the Constitution) and in African religions (as per Mbiti's (1969) definition of religion as social-cultural practices and beliefs). The study sought out synergies that can strengthen fairness and justice in ethical practices in citizen science practice and research. Emphasising this view, Mokgoro (1998) said, "the values of Ubuntu [Mbiti's 'African religion'] are the very same values that the Constitution in general and the Bill of Rights in particular aim to inculcate in our society". Ubuntu and the Constitution are already aligned; what is needed is to revive them. However, these two systems, jurisprudence and African religion, are sometimes perceived to be in contradiction specifically when considered in relation to the high level of crime and other societal ills that prevail such xenophobia and corruption in South Africa (ibid.). One challenge is that the modern institutional norms and laws have been constructed through a long history of coloniality, which is not well aligned with African cultural practices at times. Both systems have their flaws and varying implications in different contexts. However, the value of making them work together, especially in this study, is far better than simply discrediting them at face value.

3.5. Public participation and engagement

As indicated in Chapter 1, a key concern and purpose of this study is to understand the kind of participation and engagement in the uptake and use of the citizen science tools that participants attain, as well as how this happens. In this study, I focus on levels 6-8 of Arnstein's (1969) 'ladder' of citizen participation which emphasises making meaningful change. I also look at what kinds of participation and engagement bring what kinds of changes in water resource quality management. Arnstein (1969) explained that for change and empowerment to happen there must be enabling conditions created between the powerholders (decision-makers) and those who are perceived to be less powerless (citizens) (Arnstein, 1969). This is something which I consider in the uptake and use of citizen science tools for water resource quality management. In particular, I consider what opportunities for decision-making are created in and through the uptake and use of citizen science tools for the improvement of water quality management. An examination of the choices participants make, how they participate, and why they participate is at the core of this study, which ultimately

seeks to understand how citizen science projects of this kind can support participants, and how they can also support the project, for fair, effective, durable water quality management.

3.6. Social capital as a mechanism for citizen science practice

Community-based citizen science relies on social capital, i.e. group(s) or community(s). What I mean by this is, in a citizen science practice, as with the spirit of ubuntu, it is assumed that the participants belong to some form of a durable social structure or belong to social networks (Sato, 2013) with mutual recognition (Bourdieu, 1995 quoted in Portes, 1998) that facilitate certain actions of individuals. The end goals of citizen science that is community-based rely heavily on the relations between and within individuals (Rubenson, 2000; Verba et al., 1995). The make-up of those actions and relations are based on cognitive and structural forms/capital/assets such as goodwill, trust, sympathy, fellowship, shared norms, shared values (e.g. improvement of water quality), common identity, understandings, social bonds, beliefs, interests, roles, and social intercourse amongst individuals that create enabling grounding for why people work together and want to participate in improving the efficiency of the society, other than the economic value (Rubenson, 2000; Sato, 2013). These assets are about collectiveness or solidarity and collective or relational agency that also form part of the fundamentals of the spirit of ubuntu and the common good. All these assets are the relational mechanisms assumed to be in place for communities or groups who participate in citizen science practices, and thus are also present in the uptake and use of the citizen science tools.

Since social capital appears to be an important dimension of citizen science, there is a need to evaluate the environment and settings of the structures and cultures through which the social capital of the citizen scientists of this study are formed and used, as well as how that environment shapes civic or public participation for the improvement of water quality via the citizen science tools, and vice versa. Social networks are core to social capital (Sato, 2013). Because different levels and types of social capital influence individuals and groups, there is a need to probe this in more depth. Because these "social networks are not a natural given and must be constructed through investment strategies oriented to the institutionalization of group relations, [and are] usable as a reliable source of other benefits such as cultural capital – e.g. citizen science culture, actors can gain direct access to economic resources, etc." (Portes, 1998, pp. 3- 4). This needs to be considered if the intentions are to make citizen science practice sustainable and durable. Lastly, it is with the understanding that "the acquisition of social capital requires a deliberate investment of both economic and cultural resources ... although Bourdieu argued that only the outcomes of social capital can be converted to economic capital, but the processes that are involved are not" (ibid., p. 4). For social capital to be more fully

considered, there is a need to consider what processes of participation are required to acquire durable networks that may be needed for the citizen science practice to flourish as a community-based process of water quality management. Therefore, a short clarification follows of forms of voluntary civic or public participation.

3.7 Forms of voluntary civic or public participation

3.7.1 *Voluntary political participation/activism*

Verba et al. (1995) argued that first and foremost one needs to consider that a "participatory system that seems adequately representative of the public from one point of view may be quite unrepresentative from the other" (p. 2). In the context of water quality management via the adoption of citizen science tools, there may be a wide range of different voices with different capacities that bring forth different motives and concerns, which in turn bring forth different activities for different purposes. Examining all these will determine the nature of voluntary participation in the citizen science activities under study.

The ability of citizens to freely participate and engage in water governance processes is at the core of democratic and/or effective governance. This means that politically, citizens are involved in making the change they need by firstly electing who should represent them (representative democracy) and secondly, via actively influencing decision-making and actions (participatory democracy). Thus, voice and equality of opportunity for full participation in decision-making is at the heart of the democratic process and democratic participation. Verba et al. (1995) argued that representative forms of a participatory political system include voting, taking part in a range of government activities, activism, and being involved in mechanisms for recruitment and organisational membership. If citizens (e.g. the citizen scientists), need their voices to be heard and if they want to influence change, especially if the government is one of major decision-makers that influences the change contexts (e.g. as in water quality management), then citizens need to be involved in one or more of these activities. Rubenson (2000) added that there is also a need to consider the political institutions and state structures that enable or constrain participation, as well as the nature of the kinds of participation that are permissible.

Democratic governance is not, however, always as democratic and effective as idealised, 'in practice', because it depends on many variables – including the priorities of the government at the time. In the water sector, as explained in Chapter 1, even the state may have inadequately formed understandings of democracy when it comes to practice. For example, the study by Lotz-Sisitka and Burt (2006) found that while the state had put in place many structures for participation in water management, they had

not invested as much in the capacity for participating in these structures. Lotz-Sisitka and Burt (2006) noted that this was due to inadequate understandings of the model of democracy that has been adopted in the water sector, where participation is legislated in the National Water Act of 1998. Legislating participation requires a deliberative model of democracy where the state should create structures for citizens' participation. Their argument was that the state was tending to, in practice, favour a representative model of democracy, and was not adequately supporting principles of deliberative democracy, despite these being legislated in the National Water Act. Similar findings are also coming through in the recent Community-Based Water Quality Management (CBWQM) research for the WRC that this study was part of (Lotz-Sisitka et al., 2022). The Integrated Water Quality Management policy of 2017 promotes citizen science engagement and CBWQM, but in practice, this is not well supported, hence also my research (cf section 1.5.1.1.1.). Thus there needs to be recognition of the need for deliberation and negotiation on how citizen science practice of the kind under study in this thesis can be taken seriously as democratic political practice, and what opportunities need to be created for it.

3.7.2 Voluntary social and educational participation/activism

From the United Nations Volunteer programme lens, social voluntary participation is defined as "an expression of people's willingness and capacity to freely help others and improve others". They assume that communities naturally possess cultures and traditions of sharing and volunteerism. So the intent is to utilise those cultures and traditions that already exist to enhance the spirit of volunteerism for social cohesion, economic and social development. The UN volunteer programme also indicates different types of social volunteering activities with different aims which include:

- Mutual aid or self-help. This involves voluntary collective activity which is central to people's welfare.
- Service to others. This involves citizens volunteering their time.
- Participation or civic engagement. This involves engaging in government processes for strengthening good governance.
- Advocacy or campaigning. This involves citizens raising wider awareness about local or global issues.

The United Nations Development Programme (UNDP) explains how these forms of participations are important for different purposes in social and economic development. However, it does not explain what sustains them and how they should occur. These are questions of interest in this study because citizen science practice involves all these kinds of volunteering activities.

In South Africa, there are as yet no adequately constituted formal descriptions and definitions for volunteerism that fit the contexts, nor is there allocation of formal resources and structures to support and enforce the culture of social and educational volunteerism especially from the governmental point of view. In other words, the government does not explicitly support volunteerism. The problem linked to not having these definitions is that those who are involved in the volunteering activity do not know their expectations, and it becomes confusing when it comes to understanding who is volunteering and who is benefitting, who is asking for what, and for what purpose. Additionally, it is also difficult to specify what activity is for volunteering.

There are few studies on volunteerism in developing country contexts, as argued by Seabe and Burger (2021). This is despite volunteerism being described as a 'productive activity' with many benefits for those participating, include capacity building and social capital building (ibid.). Seabe and Burger (2021) argued that there are inequalities which hamper participation in voluntary activities, and with particular relevance to South Africa, they note that "marginalized populations who could benefit the most from volunteering may be excluded from participating because the activity is undertaken by people with greater economic and social resources (Haski-Leventhal et al., 2010, cited in Seabe & Burger, 2021, n.p.). The Seabe and Burger (2021) study revealed some interesting results. The authors sought to understand the influence of human, social and cultural (religious capital and ubuntu) on the likelihood of volunteering in an unequal country like South Africa. They drew upon South African data in the World Values Survey. In short, their findings are that in South Africa,

1. The previously economically and socially excluded Black African community has a greater likelihood of volunteering than that of Whites, Coloureds and Indians.
2. The employed are less likely to volunteer, which they indicate also has a relationship with unemployed people having more interest in gaining experience and skills.
3. Married people, the more educated, and the more affluent are more likely to volunteer.
4. There is a positive relationship between volunteering and bonding social capital, which shows that individuals tend to volunteer in their closed networks, "self-selecting into different volunteer activities, according to their race, education and class" (unnumbered pages, Discussion section).
5. Religiosity is an important gateway to volunteering, especially linked to the social structures of churches, and this is the case across different communities, race groups and social classes.

Interestingly, and aligned with the discussion above on the 'spirit of ubuntu', Seabe and Burger (2021) were not able to obtain results for their hypothesis of an association between ubuntu and

volunteering. They stated that this could be due to "poor proxies for the values of ubuntu" in the World Values Survey questionnaire data, or that there is a "poor correlation between ubuntu values and formal volunteering" (n.p.). They proposed that further research needs to be done on this relationship, which, as mentioned above, relates to the interests in this study.

While there are high levels of volunteering in South Africa, according to Seabe and Burger (2021), this practice is not supported or valued by the government. This is in contrast to many developed countries, for example Sweden, where the government recognises and promotes volunteerism through study circles (*studiecirklar*). These structures are established for adult education of any issue (Rubenson, 2000). Also in Australia, for example Melbourne, the local government of Whitehorse city have volunteering and community participation strategies reviewed and developed every four or five years, outlining what they are, expectations, and benefits (Volunteering and Community Participation Strategy 2014-2017, City of Whitehorse, 2014). In these plans, some of the vital critical themes mentioned that could be useful and usable for future monitoring and evaluating volunteering and civic participation in the study's context were: Managing Volunteers; Valuing Volunteers; Promoting Volunteering; Supporting Organisations; Embracing Innovation; and Expanding Opportunities.

The outcomes or benefits of these forms of voluntary social participation are assumed to be educational and economically positive and to contribute to reinforcing active citizenship due to the social capital dynamics. This active citizenship goes beyond rights and duties to include cultural identity (Pecnikova, 2016, cf. also Seabe et al., 2021).

3.8. Citizen sciences and cultures of volunteerism

One of the foundational assumptions in citizen science, is that it is a practice that is by definition a form of public participation in science-based or science-informed activity based in a culture of volunteerism²⁹ and voluntarism.³⁰ This is also the case in the GroundTruth/WESSA citizen sciences programme which is the focus of the analysis in this study. By voluntarism, Verba et al. (1995) mean the citizens **must** want to participate and be active. Because this is based on them **wanting to participate (i.e. innate motivation)**, participation involves choice and self-sacrifice. Even though there

29 Volunteerism: The use or involvement of volunteer labour, especially in community services. A person who freely offers to take part in an enterprise or undertake a task. A person who works for an organisation without being paid is a volunteer (Cambridge Dictionary).

30 Voluntarism: The doctrine that the will is a fundamental or dominant factor in the individual or the universe (Wordnik Dictionary).

are choices and self-sacrifice, voluntarism is still limited by various requirements such as time, money, civic skills (which are linked to religion – e.g. Mbiti's view of religion mentioned in the section on ubuntu, or the church-based form of religiosity mentioned in the Seabe and Burger (2021) study), participatory tools, resources, mechanisms for generating competence, institutional cultures and structures, background conditions, and agency (Rubenson, 2000) for volunteers to effectively participate in the chosen activity that has motivated their volunteerism. Thus, simply wanting to participate is often not enough for volunteers to actually be able to participate in carrying through the uptake and use of citizen science tools in the case of this study. Verba et al. (1995) claimed that even though participants might have the willpower to participate in an activity voluntarily, as a project manager one needs to consider the range of other factors that influence voluntary participation, and to consider the cost, and to work out **what is required for voluntary participation to be practised sustainably and fairly**. It is also necessary to evaluate **who is likely to be active in helping to sustain the citizen science activities**.

Verba et al. (1995) continued to say that usually the foundations or cultures for participation and being involved in activism are laid early in life, such as in the lived experience of families (i.e. intergenerational), and in communities and schools. Such organisations affect participation and determine how it happens. Seabe and Burger (2021) also pointed this out in relation to the influence of churches in co-creating volunteer cultures. Such organisations also partly determine the outcomes of volunteering programmes because different citizens bring with them different skills, experiences, relationships, capacity to convey messages, commitments, etc. Thus, if one seeks to analyse why people participate voluntarily, there is a need to trace the origins of such participation and make links. Though Verba et al. (1995) stated that institutions could facilitate civic participation, simply being involved in an institution does not fully foster participation. What matters for participation is what happens in the institution – how civic skill acquisition happens, i.e. as per the civic participation model.

Since the citizen science practice that this study focuses on is done on a voluntary basis, I needed to look at the kinds of *cultures of volunteerism* as well as *the relationship between volunteers and recipients of service* that occur in both the cases under study (the Mpophomeni community and the primary schools) in the uptake and use of the citizen science tools. I was interested in seeing how cultures of volunteerism influence and sustain the uptake and use of citizen science tools to improve water quality management.

Other studies that have considered the cultures of volunteerism at a level of individuals have identified altruism (Hussin & Arshad, 2012) and social identity (Omoto & Snyder, 2002) as a motivation or benefit of participation in the projects. Additionally, in this study, I also consider the concept of incentives such as compensation or stipends as one of the models used by the Mpophomeni community to sustain itself (see Chapter 8). At the level of the organisation (for example, the primary school teacher programme) I looked at the potential for (career) growth paths such as work performance evaluation (Omoto & Snyder, 2002) for recruiting and retaining the participants. In other words, I have considered other factors that may influence volunteerism which have not been very well documented in the literature (see Chapters 7, 9 and 10).

3.9 Summary of Chapter 3

The framework of Realist evaluation, characterized as a theory-driven approach to the assessment of interventions or programs, is informed by the substantial influence of both implementation theory and program theory, as indicated in Chapter 2. This foundational structure is further augmented by an additional stratum introduced by Weiss in 1993, thus assuming a comprehensive composition. In its essence, Realist evaluation is dedicated to the systematic exploration of the intricate mosaic that asks what works for whom, under what circumstances, how, and why? Instead of merely asking if the programme or intervention work, the realist evaluator must find the **'underlying' generative mechanisms** that explain the outcomes and the context to answer the central question. These generative mechanisms refer to the **'underlying'** internal activities and processes (i.e. social and psychological drivers = reasoning and resources) of a programme embedded within an implicit political arena (i.e. external activities and processes) that elicit the outcomes. Thus, this investigative endeavor extends beyond the surface, penetrating the intricate fabric of context, in order to comprehend the fundamental constituents that engender success for specific individuals under specific contextual conditions. To this end I have reviewed key concepts of relevance to this study in this chapter.

In the contemplation of the intricate nuances inherent to this evaluative paradigm, it was useful to draw parallelisms with the concept of Ubuntu, as articulated through Mbiti's scholarly discourse. The Ubuntu philosophy, deeply entrenched within socio-cultural contexts, signifies the interconnection of individuals within their community and the mutual responsibilities that emphasize a collective comprehension of well-being. This communal vantage point resonates in harmony with the core thrust of Realist evaluation, attempting not merely to comprehend discrete outcomes but to unravel the elaborate interplay of interactions, cognitive processes, and resources that underlie them. The notion of Ubuntu, intrinsically embedded in its socio-cultural milieu, aligns seamlessly with Realist evaluation's emphasis on the contextual dimensions that wield substantial influence over outcomes.

Just as Ubuntu acknowledges the intertwining of individual and communal well-being, Realist evaluation acknowledges that outcomes flourish from the symbiosis of internal mechanisms and the broader political arena. In both theoretical frameworks, the intricate interplay between individual agents and their context assumes a paramount role in deciphering the multifaceted tapestry of outcomes, elevating them beyond binary determinations into a realm of profound comprehension. This also brings ethics and forms of volunteerism into focus in the context of water quality management, concepts which are also elaborated in this chapter.

The basis developed in this chapter, together with chapter 1 and 2, leads into Chapter 4, which describes the study methodology and approaches used to conduct the study.

CHAPTER 4

RESEARCH DESIGN AND METHODS

4.1. Introduction

The aim of this chapter is to present and discuss the research design and methods which were applied to guide data generation and data analysis. As indicated in Chapter 2, the study draws on realist evaluation theory (Pawson & Tilley, 1997), and in this chapter I demonstrate how the realist evaluation theoretical vantage point shaped the research approach that involved developing realist evaluation case studies of two citizen science projects that I briefly introduced in Chapter 1 which were supported through the GroundTruth and WESSA partnership. To this end, I discuss the data generation tools and give an overview of the phased approach used in generating data in this study. Through this approach, I was able to gain a deeper understanding of the scope of the study as well as develop a clearer picture of the research site.

The data generation tools discussed in this chapter also give insight into the participant selection approach, which, as explained further in this chapter, was not a random but a convenient selection of the participants who were already involved in the project. After discussing the data generation process, I proceed to discuss data processing and analysis methods. As part of this section on data processing and analyses I discuss the analysis of the semi-structured interviews, and the CMO configuration which I used as a methodological approach for the interview analysis process. Furthermore, I discuss the three phases of data analysis that were employed to develop the themes that emerged in this chapter. The chapter also includes a focus on research ethics and how these were interpreted in this study, and ends with a summary that captures the main concepts discussed.

4.2. Research approach

As indicated in Chapter 1 and 2, this study is constituted as a realist evaluation inquiry that looks into the context, mechanism and outcome configuration for the uptake and use of citizen science tools. As such, the study focused on exploring how mechanisms in different contexts produce outcomes relevant to the uptake and use of citizen science tools. Identifying these mechanisms through realist evaluation inquiry is not only concerned with whether they exist or not, but also with how and where they exist. As discussed in Chapter 2, some of these mechanisms (drawing from Bhaskar's critical realism) need to be 'retroduced' (their existence is inferred), are 'intransitive' (they exist whether or not they are detected) and 'transfactual' (they are enduring, not transitory) (Scambler, 2012).

Understanding the mechanisms in this study required in-depth and critical thinking about the following components: (i) how far back in context (i.e. history) to include insights, (ii) the scope of the current context (i.e. breadth and depth), (iii) how far in the future context should one project (i.e. sustainability of the uptake and use), and (iv) how objective and real were the observations and the interpretations represented by data. These components were important to scrutinise because the study in one context, the Vaal-Triangle primary school teachers, was dealing with information, knowledge and practices that needed to be retrieved from almost three to four years back from the time of the interviews, which were conducted in 2016. Another element to consider was how the study could carefully deal with the past contexts, along with its generalised generative mechanisms and their relevance.

The following processes and approaches were applied to respond to the realist evaluation question: "What works for whom, under what conditions and why?" bearing in mind the abovementioned components, and further details of the study's specific questions as shared in Section 6.1.

4.3. Research instruments and methods

Realist evaluation research has been described as a 'data neutral' form of research which means that either qualitative or quantitative data can be generated (Pawson and Tilley, 1997) and used depending on the type of evidence and the complexity of the phenomenon under study. In a recent comprehensive study on methods in realist evaluation, Renmans and Pleguezuelo (2023) noted that 97 percent of studies reviewed showed that realist evaluators use interviews and construct understanding of context, mechanism and outcome relations around the interviews, which are used in combination with other methods such as document review, and observation as was the case in this study. They state that methods are often used iteratively to deepen understandings, and it is important for methods to continue to help identify mechanisms that shape what works for whom under what circumstances, which is often a complex question. Importantly, they also note the importance of strengthening the theory driven nature of the method (e.g. if narratives are constructed, they are constructed to deepen and understand the context, mechanism outcome configuration).

4.3.1. Interviews

4.3.1.1 Interview schedule

Table 4.1 below contains a list of all interviews conducted for the study, outlining the methods and participants involved.

Table 4.1: Schedule of interview data collection for this study

Interviewees	Activities	Number of Participants	Date
Mphopomeni enviro-champs members (core participants)	Method 1: Open-ended semi-structured interview	(2) Thandanani Luvuno and Ayanda Lepheana	February 2016
DUCT member (NGO)	Open-ended semi-structured interview (2 formal + 1 informal)	(1) Liz Taylor	February 2016
WESSA members (NGO)	Open-ended semi-structured interview	(2) Claire Herbst and Jim Taylor	December 2015 February 2016
Citizen science tools researchers (University Researchers)	Open-ended semi-structured interview	(2) Tichaona Pesanayi and Rob O'Donoghue	July 2016 October 2016
Emfuleni municipality (Government Official)	Open-ended semi-structured interview	(2) Preferred to be anonymous	April 2016
Vereeniging and Evaton primary school teachers (core participants)	Open-ended semi-structured interview	6 schools with at three or four participants per school	From August 2016 to September 2016
Metsi-a-Lekoa official (Government Official)	Open-ended semi-structured interview	(1) Preferred to be anonymous	September 2016

Table 4.1 shows the different stakeholder groups that were interviewed, as well as who was interviewed and how. Some of this data collection was done during the Water Research Commission - GroundTruth International workshop³¹ held in February 2016. Additional data was collected from the attendees via a questionnaire (refer to Appendix 1) which was used to understand the context and cohort of users of the citizen science tools. The participants were from various institutions, countries, and roles and responsibilities as individuals or groups. They also used various citizen science tools for

³¹ Attendees of the International workshop were many stakeholders including WRC, some members of Mpophomeni enviro-champs, private sector e.g. farmers, eco-schools, scientists, organisations outside of South Africa, etc.

multiple purposes. Because of these diversities, participants had different expectations and intentions for attending the workshop. Due to this diversity, I decided to focus on the participants from the Mpophomeni enviro-champs in order to better understand their context.

For the selection of the teachers, Claire Herbst from WESSA provided a list of primary schools and the teachers who were involved in the Vaal-Triangle area. The schools were the first group in Gauteng to be introduced to the tools via the WESSA implemented ORASECOM project³² around 2012/13. Hence, to some extent, this study was a follow-up to explore the extent of the uptake or use of citizen science tools in these schools.

4.3.1.2 Interview design

Interviews are the most common instrument for collecting data in qualitative studies and social science. They are also the most commonly used evaluation research tool for examining programmes' development and efficacy (Manzano, 2016). Interview processes are always dependent upon the interviewers' skills (ibid.). According to Manzano (2016), there is a need to develop realist interview skills in realist evaluation, which is theory-driven (see Chapter 2). However, there is no single prescribed way to conduct a realist interview. In Pawson and Tilley's realist evaluation approach, they differentiate between a 'realist interview' and a 'regular interview', noting that the difference lies in their underlying purpose and design. A 'realist interview' is conducted within the context of a realist evaluation, which seeks to understand how and why complex interventions work or don't work in specific settings. Realist interviews are focused on eliciting participants' experiences, perspectives, and insights into the underlying mechanisms and contexts that influence the outcomes of an intervention. These interviews aim to uncover the generative mechanisms and contextual factors that contribute to observed patterns of behavior and outcomes. On the other hand, a 'regular interview' refers to a more conventional or traditional interview approach, often used in qualitative research, to gather participants' views, opinions, and experiences on a particular topic. While regular interviews may provide valuable insights, they might not explicitly aim to explore the underlying generative mechanisms or causal processes that influence outcomes in a systematic manner, which is a central

³² ORASECOM stands for the Orange-Senqu River Commission. It is the institution responsible for managing the resources of the Orange-Senqu basin, a transboundary resource shared by Botswana, Namibia, Lesotho and South Africa. The project applied learning resources and citizen science tools compiled into a 'Orange-Senqu River Learning Box' called 'Action Learning for a Living River' which was viewed as an innovative and creative education response to the sustainable water resources management needs of the Orange-Senqu River Basin overseen by the Orange-Senqu Youth River Learning and Programme Development (OSYRL&PD). The development of this project was undertaken by the Orange-Senqu River Commission (ORASECOM). The project was implemented by WESSA (the Wildlife and Environment Society of South Africa) through workshops for teachers. They focussed strongly on the introduction of the citizen science tools to use for water quality monitoring and the objectives and purposes of this citizen science activity (see Chapter 5 for further details).

focus of realist evaluation. The distinction between the two lies in the intent and scope of the interview process. While a realist interview seeks to uncover underlying mechanisms and causal processes within a specific context, a regular interview may have a broader range of objectives depending on the research or inquiry being conducted.

4.3.1.3. Selection of interviewees and adopting a broad narrative orientation to theory generation from the interviews

The selection of participants was based on convenient selection which related to the interviewees' roles in the study and within the citizen science project/ and their close relation to the citizen science programme.³³ In some instances, respondents were recommended by those interviewed at the beginning. However, after reading the literature on citizen science practice, realist evaluation, and the citizen science project of the study, I developed criteria of the respondents I needed to interview based upon their roles in the programme. The selection criteria were based on what they could offer to the study and the aim was to narrate the mechanisms that work, from their point of view and context, and how they influence the project. This, together with the other data generation processes discussed in this chapter, allowed me to develop in-depth narratives of the two contexts and how citizen science tools were being used, by whom and what was working for whom under what circumstances, shedding light on the context, mechanism, outcome relations at play.

The following phases (refer to Table 4.1) were used in selecting and interviewing the respondents:

Phase 1: Key respondents - Claire Herbst and Jim Taylor from WESSA/ GroundTruth and Liz Taylor from DUCT

Claire Herbst, Liz and Jim Taylor introduced the tools to the schools via the ORASECOM workshop. They were part of the ORASECOM initiative and understood the 'ins and outs' of the project itself. Based on their experience, they understood the project from the grassroots level and were hands-on; their views were deeply rooted in the project.

Phase 2: Key respondents – Citizen science tools researchers

Two researchers of citizen science practice in water quality management were consulted: Dr Tichaona Pesanayi and Prof. Rob O'Donoghue. These two senior researchers had a broad overview of knowledge and experience of how citizen science practice has developed in the South African water sector. They

³³ Citizen science project and programme: Here the two terms are used interchangeably, their difference was in their longevity of operation. For example, in the case of the Vaal-Triangle Primary School teachers I refer to a project because it took a short period without any follow-ups, unlike in the case of the enviro-champs, where the programme took longer, with monitoring mechanisms, and evolution of the vision.

were also involved in conceptualising the development of the citizen science tools and the research needed to conceptualise the project in South Africa. Furthermore, they had informed ideas on the 'who's who', the processes involved, and the underlying theory of the project. Drawing on Cultural Historical Activity Theory (CHAT) by Engeström (2001) and theory of change – social science theory for the project, they worked with the study participants in various ways and played key roles in the core conceptualisation of the GroundTruth/WESSA citizen science project. They were well informed regarding the context and what mechanisms could work for which outcomes.

Phase 3: Emfuleni municipality official and Metsi-a-Lekoa official

The South African Gauteng Department of Cooperative Governance and Traditional Affairs (COGTA) was the first organisation contacted. The Department had a *#savewater* water campaign in November 2015 which it rolled out to communities to educate them about water preservation. A Member of the Executive Council (MEC) as well as executive mayors of Emfuleni Local municipality and Sedibeng District municipality participated in this campaign. This gathering and the visit in November 2015 to the Vaal areas provided a more comprehensive picture of the water issues which affected the municipality. Through COGTA I was connected to other stakeholders who were informed about water issues in the Emfuleni municipality where many schools are situated. Due to the size of Emfuleni municipality (it has many divisions dealing with different aspects), I was referred to the Metsi-a-Lekoa, a division working with potable water distribution in communities and schools. Each key informant was asked questions about their role in the project, their experiences and strategies for finding mechanisms and outcomes, and their expectations from the project (refer to the Chapter 6).

Phase 4: Subjects of the programme – enviro-champs and Vaal-Triangle primary teachers

Phases 1-4 were helpful in terms of all the phases of realist evaluation interviews (see Appendix 2 for questions asked): **theory gleaning, theory refining and theory consolidation**. I discovered that while Manzano (2016) made the process look simple, with each phase separate, in practice, the process was far more iterative. According to Manzano (2016), each phase seemed to have separate interviewees according to the knowledge and competence of the CMO configuration; for instance, she suggested that the theory gleaning can only be informed by interviewees who are in management or experts who are in a better position of understanding an overview of the programme and its mechanisms. In reality, however, specifically in this study, it became clear that the knowledge from the grassroots and management levels needs to feed into each other. Both were experts in their own capacity, making the process iterative. The 'experts' (programme developers or managers) have an assumed knowledge of contexts with mechanisms and outcomes because they were not living in the situation, while the

programme subjects know and live in the context and may have practical ideas of the mechanisms and outcomes.

Another aspect that Manzano (2016) raised was the number of interviews that the realist evaluator requires to understand the programme better. She suggested at least two or more interviews, even though she believes one can extract the information required for at least phases one and two in one interview. This was also the case in this study. Amongst other reasons mentioned in the discussions (refer to Chapters 9 and 10 for more detail), the information provided was enough to make inferences. There were also contextual dynamics to consider: the enviro-champs had mentioned that in order to sit with them for an interview, the researcher needed to empathise with their socio-economic background and poverty and compensate them for their time spent in interviews.³⁴ In the case of teachers, they did not want to miss their class lessons for the interview (refer to Chapters 6 and 8). Both reasons needed to be recognised and respected, and as a result, I had to work around which times were convenient for them, such as conducting interviews during and between lunch times or in free periods. This information was then constructed and juxtaposed with other information outside of the interviews. Interviews were then reconstructed to give meaning within the wider CMO configuration.

In the case of the enviro-champs, some of the reasons provided for participation in the interviews did not make sense until I worked with other documents, especially literature on the Mpophomeni community. For example, a statement spoken by enviro-champ Thandanani Luvuno: "you researchers come and extract knowledge from us and make books and become professors, and what do we benefit from them?" (T. Luvuno. personal communication, February 12, 2016) made sense when working on literature that confirmed that there was indeed much research conducted in Mpophomeni. The issue of research fatigue came through strongly and could be one of the reasons there was far less buy-in from the communities who had been exposed to much extractive research already. This research either for or from Mpophomeni included different fields – from political to health issues, starting in the late 1970s and conducted by both local but mostly international researchers (Denis, 2013; Denis & Dlamini, 2015; Leeb & Radford, 1987). This highlights an important characteristic of realist evaluation: some reasons or mechanisms cannot be taken at face value; instead, they need some 'digging' into the source and deeper context.

34 For families living hand to mouth, time spent being interviewed meant time that could not be spent earning enough money for the household to eat that day.

Using **theory gleaning interviews** focused on contextualising the citizen science project and its participants (Manzano, 2016), to generate information about the context, each interviewee was asked a number of general questions, which for the teachers included:

1. What do you remember about the knowledge and experiences about the citizen science workshop?
2. Who invited you and why?
3. What subjects and grade were you teaching at that time?
4. How was the teaching like before, during and after the introduction of the citizen science workshop?
5. What water issues were you experiencing at that time?

For the enviro-champs, the conversation started with me saying: "Tell me about yourself, and how you got involved into the project". These questions and the participants' stories helped me to build explanations and rigour that I could not have constructed through observations only.

As part of the theory gleaning, Manzano (2016) suggested that stakeholder referral can expand the theory or extract opposing views that can help in theory development. Such was also the case in my study. However, what was being overlooked was that power relations in those referrals can inhibit or permit interviewees from participating freely. For instance, some of the participating teachers thought I was from the ORASECOM or the WESSA committee that had initiated the project and that I was interviewing them to check upon their citizen science competencies or compliance. As soon as they realised I was not from these organisations, they started to feel more free and open about sharing their experiences. Another factor that came to light through observations was that some of the teachers seemed to have participated unwillingly merely because the principal suggested they do so. This is why it was essential to take notice of indications during the interviews of unintended coercion, even when consent had been given verbally; participants' attitudes suggested differently over the course of the interview.

As explained above, I did not need to do follow-up interviews with the study subjects. The last two phases, **theory refinement** and **consolidation**, were carefully integrated into the first interviews. This required me to be proactive in every interview, picking up the nuances of the programme and the contexts of the subjects at the local, national and international levels. However, these nuances and contexts can never be perfectly captured initially, especially since I was still learning the realist evaluation theory myself as a researcher. Therefore, recording the subjects' narratives and experiences on the programme and their socio-ecological and political contexts was necessary. In

these narratives and experiences, one could deduce what works for whom, under what circumstances and why. As for the theory consolidation, I had to look at other means of extracting information from different rich sources, some of which were deduced from the interviews. Existing sources include project documents, conceptualisation reports, project rules and protocols, municipality policies, unspoken rules and values. Manzano (2016) made a clear disclaimer that these phases of interviewing are not necessarily the only way of knowledge development of the realist evaluation (programme theory), but can be useful for the evaluator to consider during data collection.

4.3.2. Use of digital tools and their ethics: emails, audio recordings and image taking

I used audio recording as a tool to record the interviews with the participants so as to keep the interview data in its original form, which would enable me to get back to the material later during the analysis. Qualitative research, in general, is shaped by the tools we choose to use to generate data, for example, digital tools, pen and paper, audio recorders, cameras, etc. and the use of them demands that the researcher is reflexive and considers the ethics of the process (Paulus et al., 2013). At the same time, **technology is evolving** (in terms of tools), and there is an increased prerequisite for **critical conscientisation of decolonisation** in the socio-ecological and political pedagogy and research in South Africa and Africa (Karam & Mutsvairo, 2022; Le Grange, 2018b; Seroto, 2018; Trisos et al., 2021). It became apparent that many considerations are needed. Paulus et al. (2013) warned that whilst admiring technology advancement which is both inescapable and beneficial for research (e.g. enhances transparency, trustworthiness, promotes collaborations, etc.), we should take cognisance of its constraints and affordances. There is a need for qualitative researchers to be reflexive about the perceptions and ethical dilemmas related to digital tools, both amongst adopters and resisters, in particular the scholarly community, the general public and the participants (or interviewees).

Reflexive practice as it relates to the use of digital tools is important in realist evaluation (programme theory) because the relationship between the researcher, context and the participants can be sensitive (e.g. culturally, politically, gender, racially, economic status, positionality, accountability, etc.). Identities of researchers and participants cannot be divorced from how we shape the way we make sense of the world. It is not always the case that everyone would want information (e.g. poverty status, gender, etc.) to be exposed; respect for such things reflects reflexivity for practising democracy and respect for privacy in qualitative research (programme theory). Hence, it requires transgressional courage and ubuntu, sometimes simultaneously. I emphasise that making such choices and decisions matters because they form integral components of constructing and reconstructing the history and social sciences of 'other' communities and their values. And it can only be fair to represent them with dignity and respect. I thus took utmost care in how I was recording and representing participants

voices using digital tools, and also how these were used in the study construction, respecting for example if people wanted visual records included or not. I also carefully protected the audio recordings using these only for the study purposes with permission from participants as will be discussed in the ethics section.

4.3.3. Attending training and workshops

As outlined previously, realist evaluation practice functions better when applied in an ongoing programme, more like action research, but with more breadth and depth of focus on what is or is not happening and why. Both are participatory, where the researcher is not only investigating the subjects but also conducting the investigation with them, whilst evaluating the circumstances to better the outcomes of the programme and beyond. Here, the researcher can knit the fabric of the research whilst also becoming part of the fabric (e.g. feeling the texture whilst interpreting it, etc.) to be more appreciative of the activities and processes involved. Thus, attending training and workshops helped me distinguish between the activities and processes involved in the programme, and how stakeholders have different roles or interests based on the activities and/or processes involved.

What is crucial to the study is that it is located in the ongoing inquiries into the efficacy and scaling of citizen science tools for CBWQM. Hence, to gain an in-depth understanding of the general context of the uptake and use of the citizen tools, I had to follow the tools. I had to look at what tools were used and where they were introduced, how they were introduced, who was the target market, how the target market was trained and how each participant received the training. The following table (see Table 4.2) explains which training and workshops I attended and why.

As indicated in Chapter 1, this study was part of a wider WRC CBWQM project (Lotz-Sisitka et al., 2022) with its own specific focus. However, I was able to participate in various of the WRC CBWQM project meetings and conversations, and I was also able to join into another citizen science community of practice during the study which allowed for iterative deliberation and deepening of the theory perspectives in the study. This was in the form of a social innovation lab for citizen science practitioners workshop, which was set up by myself and three other PhD scholars working on citizen science research. This workshop combined four citizen science studies: three PhDs and one Masters study (of which mine was one), to tease out the investigated concepts with the practitioners so as to improve the ontology and practice of citizen science. Hence, the study was shaped by and reshaped the practice of citizen science in general, and was also a useful reflexive experience for me as scholar working on my study.

Table 4.2: Workshops and training attended by the researcher

For details about the citizen science tools, refer to The Water Wheel created by the Water Research Commission (WRC) in September/October 2018 (Matthews, 2018b)

Tools introduced	Location and purpose	Audiences	Training programme	Date and longevity of a workshop and training
miniSASS ³⁵ kits and miniSASS App, Enviro Picture Building game	Johannesburg (Birchwood Hotel) Youth Water Summit -Testing the water quality of Bloubokspruit in Kliprivierberg nature reserve using miniSASS kits.	Learners and primary school teachers, and government officials (i.e. Department of Environmental Affairs and Department of Water and Sanitation), WRC, WESSA, GroundTruth	- Plenary introductory session on the tools. - Buses took the attendees to the nearby streams for demonstrations. - Split into groups, with WESSA or GroundTruth facilitator and training. - Discussions and application of the miniSASS app to locate the sites and Catchments to Coast map.	July 2015 - one hour training
Turbidity tube, Velocity and discharge plank, miniSASS kits.	Pretoria – Moreleta Park – on-site training with the Adopt-the-Moreleta Spruit community. - testing the water quality of Moreleta Spruit, velocity, discharge, and turbidity.	Resilim B, scientists, Moreleta Park citizens, pensioners, students from University of Pretoria (UP) and Tshwane University of Technology (TUT), British Embassy, etc.	Demonstration of how to use the citizen science tools in the Moreleta Spruit.	December 2015
miniSASS kits, turbidity tube, velocity and discharge plank, Riparian Health Audit tool, e-coli count, homemade rain gauges	Howick - International citizen science workshop (2 days) to disseminate citizen science tools for improved water resource management Citizen Science: The next wave in water resource assessment and monitoring	Citizen science tools users, citizen science tools developers, eco-school teachers, enviro-champs, farmers, scientists, NGOs, government official, WRC, etc.	- Overview of who is using what citizen science tools, why and how. - Sharing the challenges and enablers - Introduction of the tools and how they are used - Applying the tools in the stream passing by the GroundTruth offices	February 2016
miniSASS, WRC Thirsty Three comic book, clarity tube, Google Earth mapping (www.minisass.org)	Johannesburg (Aviator Hotel O.R. Tambo International Airport - EEASA ³⁶ conference) - Citizen science in the SADC region: Cutting	SADC citizens, WRC, WESSA, GroundTruth, Association for Water and Rural	Demonstrating how action learning facilitated by the uptake and use of citizen science tools can support Sustainable Development Goals (SDGs).	October 2016

35 miniSASS – mini Stream Assessment Scoring System

36 EEASA - Environmental Education Association of Southern Africa

	edge changes in social learning for wise water management"	Development (AWARD), etc.		
10 water quality management citizen science tools were introduced	- Establish the extent of citizen science's existence in South Africa - Ascertain the various activities conducted under the concept of citizen science - Discuss consolidation of activities, including data collection, archiving and reporting - Explore the need and feasibility of establishing a Citizen Science Society of Southern Africa - Explore the interaction between policy and citizen scientists' efforts	Mostly natural science researchers, WRC, WESSA, GroundTruth, Department of Science and Technology (DST), Department of Water and Sanitation (DWS), AWARD, Universities, NGO's, etc.	Discussions about the overview of the uptake and use of citizen science tools in the environmental sector.	October 2016
Launching of the 10 water resource quality monitoring tool-box - citizen science tools	Pretoria - Launching of citizen science tools	WRC, DWS, community groups, NGOs, Water Boards, researchers, academics, biodiversity institutes, local and national government, business, entrepreneurs, civil society representatives	Presentation and demonstration of the Citizens science monitoring toolbox and how to use them.	March 2019
As researcher, I was involved in linking projects to the uptake and use of citizen science tools in two ways: upscaling the uptake and use of citizen science tools, and integrating social ethics.				
1. Research into Alignment, Scaling and Resourcing of Citizen Based Water Quality Monitoring to Realising the DWS Integrated Water Quality Management Strategy (CBWQM Project)		WRC, WESSA, Rhodes University, GroundTruth	From 2018 - 2022	
2. SDG Lab workshops: Citizen science for the common good. A social innovation lab for practitioners. (All the citizen science tools)		Rhodes University (ELRC) – Citizen science researchers	July 2019 and August 2019	

4.3.4. Using document analysis to maintain CMO theoretical awareness

Throughout the study, the use of document analysis as part of the data collection method ensured that the **analysis procedure and its outcomes (findings) were explicitly elaborated**. How documents are selected and analysed as a data source in a qualitative research process can serve different purposes, which need to be explicit, showing that the chosen approach was systemic (Bowen, 2009;

Elo & Kyngäs, 2008; Stemler, 2001; Wach & Ward , 2013). Bowen (2009) further argued that there is a place and function for documents in qualitative research, noting that document analysis is iterative, and that **document selection is always biased and limited** because data available is not designed with the purpose of the particular research study in mind (ibid.). **Sources, specifically the documents, could be anything or coming from anywhere**, for example:

advertisements; agendas, attendance registers, and minutes of meetings; manuals; background papers; books and brochures; diaries and journals; event programs (i.e., printed outlines); letters and memoranda; maps and charts; newspapers, press releases; program proposals, application forms, and summaries; radio and television program scripts; organisational or institutional reports; survey data; and various public records, scrapbooks, photo albums, previous studies, document reviews, mission statements, programme documents, reports, beliefs, practices, etc. (Bowen, 2009, p. 27)

There is also a **blurred line or no line at all** between document review, document evaluation, document analysis (Bowen, 2009), literature review, literature analysis, qualitative document analysis (Wach & Ward, 2013), content analysis (Stemler, 2001), and qualitative content analysis (Elo & Kyngäs, 2008). This is because they all provide historical context or background information of the concepts or issues of the study, or context of the research participants. Typically organisation of themes or categories is either inductive or deductive (Elo & Kyngäs, 2008). Bowen (2009) further explained that document analysis involves skimming (superficial examination), reading (thorough examination), and interpretation. The above-mentioned processes were part of developing the CMO configuration theory in this study and were applied throughout the whole process of data analysis and thesis writing. I applied step-by-step processes in document analysis as a standalone procedure and as only raw data in the policy review (Bowen, 2009; Wach & Ward , 2013).

Table 4.3 below offers an overview of the documents analysed in this study, main analysis foci, and outcomes or key findings. More detailed insights into the value of documents analysed can be found in Chapters 5-8 where document analysis is iteratively used in relation to other data sources in articulating the CMO configurations in the two cases.

Table 4.3: Documents selected as the basis for the study

Documents selected	Data analysed	Outcomes/Findings
The first round of document analysis involved the GroundTruth documents: Graham, M., Taylor, J., Pesanayi, T., & Bruton, S.	The conceptualisation of the programme, assumptions and intentions, and stakeholders involved. The assumptions of how	A push for social learning in a building of water-science knowledge society.

(2014). <i>Development and Innovative Use of Community- Based Water Resource Monitoring Tools to Research and Mainstream Citizen Science and Improve Trans-Boundary Catchment Project No . K5 / 2350 June 2014 i, (June).</i> ▪ <i>Deliverable 4: Literature Review. Report to the Water Research Commission.</i> ▪ <i>Progress Report Report</i> ▪ <i>Deliverable 2: Inception Report Report</i> ▪ <i>Deliverable 5: Framework of the Toolkit</i>	the program should be organised and why and how the program is expected to work. CMO	A need for public participation for better public governance.
Policies on water quality management linked to the claims made in the documents submitted to the documents mentioned above submitted to the WRC.	CMO	Linking policies and finding opportunities that enabled or constrained public participation.
Then followed the reports about citizen science tools: <i>miniSASS study at Foz du Iguassu – Brazil 29 July 2016. A short report by Jim Taylor (WESSA South Africa)</i> <i>Resilience by Design Enviro-Champs: Community Mobilisation, Education and Relationship Building Notes for a workshop by Jim & Liz Taylor (Third Draft 12 June 2016)</i> Cele, S. (2015). <i>Citizen science for water quality monitoring and management in Kwazulu-Natal. University of the Witwatersrand.</i> MiniSASS resources http://www.minisass.org/	Looking at the ideas the programme developers were exploring and their experiences, insights, generalised assumptions, the kind of knowledge creation and management, capacity development, its potential for policy influence, capacity to improve flow of information, all in the context of the uptake and use of them. CMO	Citizen science practice is more practical and it transcends language barriers. Its activities are educational and fun.
Citizen Science Tools ability to become the knowledge and information intermediary mechanism	For enabling access to information; helping people to make sense of it; and facilitating connections that enable knowledge to be shared between stakeholders. CMO	
Municipality documents – IDP Draft 2018-19 IDP Review	Employment details Environmental protection Positions (1)/ Vacant Environmental Protection Positions (0) from 2015 – 2018 Environmental Awareness and Capacity Building (cost 280k)... priority issues about water source or water quality etc. ... uMngeni sector contribution to employment (electricity, gas and water – 0%).. Priority needs per ward – implementation plan stormwater maintenance or infrastructure ... investment plans..skills development plans. CMO	What did they get out with after being in the programme? What were the general assumptions about the uptake and use of CST for their livelihoods? What options did they have? (T3-T4) Did they all have the same experience? Occupationally what happened to them upon graduation or leaving the programme?
Lesson plans designed by WRC, WESSA, GroundTruth and Fundisa for Change	How they were developed and aligned with the CAPS curriculum	Which subjects supported the uptake

WRC: Project No. K5/2350	documents. They were examples of what is possible for the water quality citizen science practice. CMO	and use of citizen science tools for water quality management?
International and continental documents – SDGs, AU agreements	CMO	Opportunities for the citizen science practice for water quality management and public participation
WRC scaling of citizen science deliverables leading to final report 2019 –2022	Lens used to understand the overview of the use of citizen science tools in the community based water quality management	Locating the study and its contribution

4.4. Process of data generation

As introduced above, and explained further below, the study's methodology was designed to find ways to carefully extract responses that shed light on the deep-seated mechanisms at the level of the real enabling or constraining the uptake and use of CS tools in the two diverse contexts, and also how activity mechanisms at the level of events and empirical experiences were packaged to serve the purpose for each context (Pawson & Tilley, 1997). By 'packaging', I meant finding the activity mechanisms in the contexts that formed constituents which were empirically visible in the process. As indicated in Chapters 6 and 8, there was also a need to seek insight into the deeper mechanisms of CS as explained via critical realism, and to find mechanisms that were omitted, or overlooked in the real, actual and empirical domains. As explained in Chapter 2, identifying such mechanisms meant carefully applying the processes and procedures that brought ethics to the fore in order to reveal and extract them. This chapter explains this methodological process in more detail.

4.4.1. A contextual and culturally sensitive approach to data generation: Laying the groundwork of the study's theoretical framework and its conceptualisation

I begin with a narrative account of the procedures that I followed in interviewing the key informants (refer to Appendix 3), as this was an important phase of 'laying the groundwork' for the study. It also explains how I gained access to the field, which was initially unfamiliar to me. The procedures that I followed were initially informal, however, after initial informal interaction, I would request a time for availability for more formal interviews and interactions. I interviewed Professor O'Donoghue and Dr Pesanayi (ibid), and in both cases, the discussions were more along the lines of starting a conversation in continuum because I had consulted them often to seek advice and inputs as I went along. The advantage of this kind of set-up was that they allowed me to contact them whenever I needed clarification, which allowed me to continue the conversations with them.

Prof O'Donoghue provided information and documents on the history of miniSASS and Dr Pesanayi provided information about ORASECOM and connected me with one of the more involved coordinators. This coordinator then referred me to the ORASECOM website. I also connected with Ms Claire Herbst from WESSA when I was referred to her by Dr Pesanayi, and I met her in their office in December 2015. She added invaluable information on the **ORASECOM River Learning Box project** and which primary schools in the Vaal-Triangle were involved. She provided a list with contact details for the schools, as well as details of the municipal government officials and Rand Water officials who were involved.

Prior to meeting Claire Herbst, a friend – David Mokoena (CoGTA³⁷ official) – invited me to the National Department of Corporate Governance and Traditional Affairs (CoGTA) water campaign in November 2015 entitled: 'Media alert – Taking #savewater to the communities and strengthening the water campaign'. This was a campaign whereby the CoGTA and Human Settlements MEC Jacob Mamabolo met with the Vaal-Triangle municipality officials and visited areas and communities with water challenges, such as water supply or manhole infrastructure problems. This was another opportunity to frame the bigger picture and context, looking into how municipalities operate in the water sector. It was also an opportunity for me to introduce my project and meet the officials whose work related to it, enabling us to create a working relationship and build trust for future engagements. Through attending the campaign, I managed to get the contact details of Mr Gundo Maswine, who, at the time, was the executive director for infrastructure development at the Emfuleni municipality. He explained why the **ORASECOM River Learning Box project** was introduced and the socio-ecological and political issues and infrastructure problems that the Emfuleni municipality was encountering along the way. He also provided the history of those issues and explained the structure of the Emfuleni municipality (G. Maswine, personal communication, April 15, 2016). Lastly, he connected me with the government officials involved in the water sector, specifically those involved in the school programmes at Metsi-a-Lekoa.³⁸ From there, I made an appointment with the government official from Metsi-a-Lekoa. Unlike other government officials mentioned above, he preferred to remain anonymous, which I respected.

37 COGTA – the National Department of Cooperate Governance and Traditional Affairs has 'play your part in saving water' programmes and are responsible for ensuring that all municipalities perform their basic responsibilities and functions consistently.

38 Metsi-a-Lekoa – the dedicated water services authority entity for Emfuleni Local Municipality. Its functions, amongst others, include customer care – which is focused on communicating to communities through awareness programmes.

I collected information from him on how they work with schools, the details of which are shared in Chapter 6.

The approach to collecting contextual information from the key informants about the enviro-champs programme in Mpophomeni was different from the context with the Vaal-Triangle schools. Here, I attended an international citizen science workshop in February 2016 held in Howick. During the workshop, I was in contact with Ms Liz Taylor who worked for the Duzi-Umnjeni Conservation Trust (DUCT) NGO as manager of the Mpophomeni enviro-champs and overall project coordinator. I had some informal conversations with her, which led to a more formal interview conversation, in which she provided information on how the project started through DUCT and how it became what it was over time. She then introduced me to Thandanani Luvuno and Ayanda Lepheana from the enviro-champs programme, and via initial informal conversations with them, and shared travel to Mpophomeni, I was able to chat to them about the project and see Mpophomeni township and how the streams connected to nearby Midmar Dam. As we were travelling, we passed Mpophomeni's dumping sites, an area that the enviro-champs spoke about as a challenge both to the community and the health of the streams. I followed up these initial meetings with further informal interactions and then requested a formal interview with each one. The informal interactions were important as I was able to build trust and create a space for them to communicate freely with me during the interview. Liz Taylor by this time had also provided me with a list of the enviro-champs, the project history, and other documents related to the project.

Another instrumental key informant was Dr Jim Taylor (Director of Environmental Education at WESSA), who I connected with often during the whole data collection process. He was instrumental in the initial set-up of the citizen science tools and worked originally with Prof O'Donoghue to start the first miniSass citizen science tools and projects while he was education director at WESSA in the early 1990s. He told me about different locations where citizen science tools were used for various purposes. He also provided invaluable information on where the tools were being applied, and how they introduced the tools to different stakeholders, both locally and internationally. Finally, he provided very useful documents, which were mostly reports on the use of the citizen science tools.

4.4.2. Cultural and ethical dimensions guiding interviewing of participants

By the time I interviewed participants from the two sites, I had gathered background of the interventions, how and when they were introduced, and the reasons why they were introduced from the project developers' point of view (as indicated above). I also had a list of all the schools and a

contact list of teachers from each school, a list of participants of the ORASECOM project and WESSA as well as a list of the Mpophomeni EnviroChamps. However, I found myself grappling with substantive cultural and ethical dimensions before going into the interviews, which I discuss in more detail below as this was also integral to the research and the way it was done.

The next step was to do '*matseno*' (the direct English translation here is 'the introductions' – such as introducing oneself to a family) or '*go kokota*' (the direct English direct translation here is 'knocking' – referring to knocking on the door of a house). These concepts are commonly used, for example in the negotiation of 'lobola'.³⁹

In this case, and in plain English, I would be introducing myself. However, *matseno* or *go kokota* in Setswana has a deeper meaning. It goes beyond explaining yourself professionally, about who you are, what you do and where you are coming from. *Go kokota* has connotations of 'I come in peace with good intentions of building a relationship with you and must be alert of my future correspondence since I am unknown to you. Also, I intend to come back to you; thus, my future correspondence must not be of a surprise'. The procedure demonstrated **a gesture of respect for cultural values and aesthetics**, which are often non-material and have been overlooked by those who are not familiar with these values. Sometimes, as Ghoshal (2018) argued, such "ethical procedures and ethical validity can be overlooked, in the excitement over the attainment of scientific (or research) value and social value – and it is incumbent upon the researcher to remain alert to these shifts and possible slippages" (p. 8). Though this gesture can be received differently by different generations or peoples, it can be beneficial to the authenticity of the study if the participants are familiar with its values, especially the older generations. Familiarity with these values can influence how the participants reciprocate in the interviews and conversations.

Cultural procedures for 'go kokota' in the teachers' case: The approach to contacting the participants was informal, but formal letters inviting participation were sent out via email to the participants in the schools (refer to Appendix 4). The content in the letter (see Appendix 5) was explicit, stating the context of the study (as explained in Chapter 1), and that participation was voluntarily and was not enforced by either the Department of Education, the municipality or the citizen science projects. This process was necessary and including it demonstrated professionalism and rigour. However, the issue here was that the participation I was requesting was not compulsory and not enforced by the school,

39 Lobola is the practice of paying a bride price or dowry. The primary purpose of lobola is to build relations between the bride and groom's families. This relationship is seen as life-long with mutual benefits.

meaning their participation required personal agency, something beyond professional letters. For me to reach out, I needed to *speak at the level of ubuntu and their compassion*. I was at their mercy to make the interviews happen, and I needed to respect this.

Step 1: Sending emails. Sending emails first to people unknown to me was risky because emails can sometimes be considered as letters of command, especially when written in English (refer to Appendix 4), and there was a good chance they would not be read. I understood that schools are professional spaces, while at the same time, they symbolise personal spaces or homes. To engage with care and being thoughtful were not duties but rather innate responses. It was essential for me first to introduce myself over the phone to pass on a sense of sincerity behind the requests, especially when the conversation could be held in their native language. I sought to put them at ease and show that I did not come with authority – this was the first step to building trust. For the teachers, I made sure to contact principals first to demonstrate respect for their authority and position in the hierarchy of a school's structure. Afterwards, I would talk to the teachers I had selected as participants, or sometimes the principal would choose the teacher on my behalf. In the conversation, I would make them aware of the email with the letter of request for their participation, and sometimes I explained briefly what the letter contained. The phone call procedure was important firstly because the citizen science intervention that I was reinvigorating had happened a long time ago, around 2012/2013, and the interview was now being conducted in 2016. Teachers thus needed some reminding and time for preparation. Secondly, I needed to ask if the teachers would be comfortable with the follow-up interview and if they could recommend other teachers who would be interested who had also been involved previously (Refer to Appendices 6 and 7). These engagements were helpful as a tool for collecting and connecting memories, both in the collective and as individuals. At this stage, the principals and the teachers acquired knowledge about who I was and what my intentions were.

Step 2: Making telephone calls. The introductory telephone calls aimed to support the email sent shortly thereafter with a formal letter attached requesting participation. In the email, there were two requests. The first was to ask if they were still interested in participating. The second was a follow-up request for those who showed interest to select a date and time of their availability (refer to Appendices 6 and 7). Both the calls and the emails were part of a process that showed *respect for being at their mercy and honouring their participation*.

Step 3: Explaining my intentions during the interview. After the schools and the teachers involved had agreed to participate, despite having explained what the study was about in the letters (refer to

Appendix 4), I had to explain again before I began every interview. This was to ensure a free and comfortable environment for the participants to engage and question what mattered. Also, to ensure that the participants did not feel obligated to participate and felt there would be common value in participating. I then asked them to fill in the consent form (refer to Appendix 6 and Appendix 7) only if they agreed to continue being interviewed. Though the study was in a pilot phase, filling in the consent form was a standard procedure. All the schools were made anonymous to avoid bringing harm to the schools or educators. Most educators chose a time for interviews which would avoid interrupting their class lessons. During the interviews, they were allowed to attend to other emergent issues that would arise, because it was during school hours and I respected that any interruptions were often related to their teaching schedules.

Cultural procedures for 'go kokota' or 'knocking' in the Mpophomeni enviro-champs' case: As mentioned earlier, the process for 'go kokota' in the enviro-champs' case was different because opportunities presented themselves differently. Though the process was different, there was still every reason to be sensitive to ubuntu values and ethical procedures and gestures – to demonstrate appreciation of the values of the enviro-champs as people, as well as respecting their personal dignity. However, different circumstances required different ways of applying such values and procedures. The point of the process was to pay due diligence and respect to participants as people and to their practice (culturally), as well as to respect them as active citizens. Lastly, I needed to show respect for their selflessness to entrust me with the gift of their invaluable time, knowledge, and stories, hoping that I could do justice to them.

Before the interviews and meeting with them, I had conducted desktop research on the values, relations, cultures and structures of Mpophomeni to get a general picture of their differences and commonalities. I found information from Leeb and Radford's study (1987), *Research in the Black Township of Mpophomeni: Is there hope?*, useful to set the tone for my further engagement there, as discussed below.

Firstly, their study was conducted in 1987 during a critical time in South Africa's history, characterized by apartheid rule and racial segregation. The study explored the history of the socio-economic conditions, social and psychological legacy of apartheid and living standards in the Black Township of Mpophomeni, which today one would assume the conditions had changed for them. This period marked the height of the apartheid regime's oppression and discriminatory policies, which significantly impacted the lives of black communities. They highlighted the impact of unemployment

and poverty on individuals, families, and the community, while also shedding light on the broader challenges faced by this marginalized community. The key messages were about the (a) **social and economic disparities** between Howick, the neighboring white residential area with affluence, and Mpophomeni, the black township characterized by poverty and lack of opportunities; (b) **unemployment and poverty** how majority of households lived in dire poverty, struggling to afford even basic essentials like food, housing, and clothing; (c) **psychological distress about the** high levels of stress and psychological distress, particularly among the unemployed population. At the same time the (d) **community solidarity and struggle**, that is despite the dire circumstances, the community had the sense of community solidarity and community mobilization, such as the successful bus boycott and participation in strikes, the indication of their determination to stand up against adversity. (e) **Desire for Change**, the residents express a strong desire for change and improvement in their living conditions for example better infrastructure, access to clean water, sanitation facilities, healthcare services, and employment opportunities. The community members show an interest in self-help initiatives and the creation of businesses to address their needs. Also, at the end the article showcase the (f) **positive outlook and resilience**, a belief that change is possible, and even amidst adversity, the residents maintained faith in their capacity to overcome challenges and create a better future.

This article reminds us about how the history of the past still affects communities today. It shows that the struggles and challenges [also social cohesion norms and values] from the past continue to impact how communities try to improve and empower themselves. Analysing the Mpophomeni's past, from this article's view, helped this study to understand the bigger picture of what the community carried and faced. I draw this study's view from this article, because there haven't been many other studies that have looked at how things have changed over time and looked at these small, important details, of the Mpophomeni community. This study found that these historical insights were crucial and coming out even when gathering information from the enviro-champs. Therefore, I as the researcher, needed to be careful, sensitive, aware, and innovative when studying the Mpophomeni community's situation, with the aim to make a different and positive meaningful impact.

Given the ongoing prevalence of the poverty paradigm within the current societal context, and its enduring salience, it became imperative for this educational investigation to delve deeper into the research attitudes surrounding the conceptual descriptions of 'underprivileged communities,' 'impoverished communities' (Denis & Dlamini, 2015), and the identification of a 'most disadvantaged community.' Whether from the individualistic or structural or fatalistic terms (Davids, 2010; Davids & Gouws, 2013) it has tacit or hidden stereotypes that need to be unpacked, which relate to the hydro-hegemony discussed in Chapter 1. The overarching objective is to unearth latent biases that might

underlie these conceptualizations irrespective of their theoretical underpinnings. It is recognized that implicit or concealed stereotypes could be embedded within these perspectives, warranting a systematic unpacking.

Moreover, the problem is that the deeper connotations have implications for values and ethics, mainly if the 'poor community' has been extensively researched and especially if circumstances have not improved through such research. Mpophomeni was one such example. It should be noted that these differences didn't mean that the enviro-champs should benefit more from the study or project than the teachers; however, the connotation of a poor community which had already been extensively researched needed to be unpacked and problematised – specifically in relation to the community's access, their freedom to participate and negotiate benefits/hopes/social values, and the ethical procedures that needed to be put in place. These follow the social injustice scepticisms about research in their community that can be linked to **the scepticisms** emerging from the study on Mpophomeni conducted by Leeb and Radford in 1987 as listed below (p. 17):

- It was felt that often the researcher decides what the problem is before the investigation. The research thus assumes a Western 'white' frame of reference, and the researcher operates within this perspective. This means, the 'researcher decides what the problem is before the investigation' regardless of their racial background. However, this aspect highlights the role of the researcher in shaping the research agenda and framing the research questions. If the researcher, irrespective of their racial background, approaches the research from a Western-centric perspective, it may lead to biases in problem selection, research design, and interpretation of findings. Such biases may stem from the dominant cultural, social, and historical influences that have shaped the Western worldview.
- However, the assertion also highlights the existence of a broader issue in academia, where historically, research paradigms, theories, and methodologies have been predominantly shaped by Western perspectives. This dominance can influence the way research is conducted, and it may lead to the marginalization or misrepresentation of non-Western voices and experiences. Therefore, efforts to promote diverse and inclusive research practices that incorporate multiple perspectives and frameworks are crucial for developing a more comprehensive and equitable understanding of complex global challenges.
- The consequence of this, is that information collected from community members is analysed in terms of this frame of reference and becomes divorced from the real problems in the community.

- Very often, the community being researched has only one contact point with the research – when the data is being collected. They are not informed of the results.
- The research data is then interpreted within the 'white' perspective and published in specialised journals. It is then read by other academics and catalogued in libraries. Consequently, the people whom the research was meant to benefit in some way never hear the actual research outcome.

These scepticisms invoke questions around the status of the psychology, attitudes and perceptions of 'the poor' in research situations – for example: what are they hoping to achieve? How is value creation discussed? How is poverty perceived in research? Poverty as a social determinant of development has been a big challenge in South Africa, as in other African countries and across the developing world. Poverty and its implications continue to impact many sectors, including health and water supply and sanitation. They were also observed during the Covid-19 pandemic. Asking disadvantaged participants to sign consent forms, etc. and getting their agreement to participate is not enough. This is especially so when participation allows vulnerability to be exposed to social, economic and livelihood risks. Therefore, one of the responsibilities of socio-ecological research like this study is that it should be honest and practical enough to expose such fault lines in our societies through the research. There is also a need to improve research by strengthening social protection that promotes inclusive knowledge ownership by those studied or studied with, restoring dignity and allowing participation that is transformative.

The advantage of the realist evaluation characteristic of this study was that it evaluated the potential of the mechanisms used and whether they could be translated into future, possibly broader contexts of water quality management through the citizen science tools. Thus, it was essential to evaluate their sustainability and the meanings of commitment and agencies from each case.

4.5 Ethical considerations

This study followed the ethical protocols as identified in the social ethics guidelines for social and educational research (cf. section 4.6.1 below and Appendix 6). These included aspects such as transparency, respect, voluntary consent, and options for anonymity, as well as negotiating protocols that allowed participants to exit the research setting if they so wished.

However, as indicated above, contextual and other historical, social and political dynamics produced ethical considerations that needed to be taken into account. Firstly, the intention of dealing with

sustainability challenges that meet the needs of the present and future generations is a complex space to engage in ethically, which also relate to the spirit of ubuntu perspective introduced in Chapter 3. This is a battle because ethics do not only involve protocol descriptions (i.e. *descriptive ethics*) of different disciplines, institutions, and participants involved and how they are related to getting the general view of the world from the observations' perspectives. Ethics are also *prescriptive* – Mbiti (1969) noted that one needs to inhabit those religious practices to understand them fully. This then challenges the observer's view on making a moral judgment and defining what is professionally and socially acceptable. Defining what behaviour is wrong or right (e.g. behavioural ethics) and the standard of what harm can be inflicted on other moral agents (e.g. consequential ethics) (Jennings et al., 2009) can be daunting. Because of the different types of ethics, the battle I encountered was between the position (in the environmental education profession) I hold as a researcher and the institutional cultures and ethics that govern the study and my own cultures and beliefs. Ultimately all ought to have contributed to how I handled the sensitivity, ethics and integrity of the study which is expected to involve *academic rigour* – all of which are also limited by the reality of applying some of them in the contexts. I intentionally included how I as a researcher was affected by the study, because when dealing with ethics, ethics in themselves can be the “source and normative content of a particular decision by providing reason and justification” – of why and how I made decisions in the study (Jennings et al., 2009).

The conundrum about the concept of ethics in this section also found itself at the problems of methodological approaches (of doing things, e.g. research), embedded within decoloniality. It puts the issue(s) of decoloniality at the centre of ethics. Decoloniality, in this case, was explained by Ndlovu-Gatsheni (2013) cited by Cherrington et al. (2018) as a process(es) that enables liberatory thought and practices that allow other knowledges and worlds. He explained decoloniality according to three levels of understanding: epistemic, political, and methodological. In this section, it is the methodological level that is of interest to this study. This level is about finding those processes that are about,

rebelling against the knowledges of equilibrium and those methods that operate as part of colonial matrices of power that prevent transformation... aimed at disrupting prevailing power structures and institutional cultures to shed light on democratised practices and spaces that bring to the fore previously marginalised voices and knowledges [and practices also echoed with the Action Plan No:14 of the UNESCO Universal Declaration on Cultural Diversity (UNESCO, 2006)] ... for transformation and renewal practices to be impactful in the academy, we should, with our students and through critique, contribute to the self-clarification of the struggles within our universities. Such introspection and dialogue might expose how, in

epistemic terms, the systemic anchoring of socio-economic inequalities and discriminations in institutions are, in part, constituted and reinforced by the everyday praxes of individual social agents. (Cherrington et al., 2018, p. 1, my underlining)

This thought opened a space for debate about ethics and how I relate to them as a researcher, and in research.

Also importantly, I looked at how the study in itself was at the end and with its processes (in its entirety) being sensitive or not to the research participants' views (e.g. voices, hope or expectations). What I mean by the latter is the most critical feature of Mbiti's (1969) work on ethics about the careful psychological reflections on combating the mentality of deity/goddess/superior being as a researcher. Weber (1930) explored protestant ethics or utilitarianism. It is important also to be careful of not taking advantage of (or taking for granted) the research participants who might not know the extent of the power (i.e. material and symbolic form, and its implications) of knowledge and knowledge as the power they contribute to the study. Take, for example, enviro champ Thandanani Luvuno equating his knowledge and time linked to participation with a meal. As a researcher, I had to question if my thesis (which will ultimately produce a qualification of a PhD respected in academia and lasting forever), which is partly made up of his knowledge, was really worth a meal. The idea of ethics (and justice) is really a space of challenging one's humility, honesty and sensitivity (also institutions' ideological perception about research participants of this kind). Where one has to find a fair balance between the research participants' views and meeting scholarly merit. For instance, respect as part of the ethics involves respecting the research participants by not treating them as passive objects and as if what was before them was worthless (Mbiti, 1969); treating them in that way as an environmentalist and socialist, I would be no different to a capitalist. It would be the same as getting the most of what I want for the benefits of my study. Or I could be seen as legitimising the apartheid racial hierarchical ideology of taking the research participants backwards and in need of control (Stull et al., 2016).

The battle I really struggled with in this study was within the domain of ethics between (i) the channel (s) of the intervention implementation through **institutional (scientific) ethical protocol** (e.g. the missing link in the DEA ethical protocol, NGO ethical protocol; the channel(s) of conducting the study through Rhodes University ethical protocol); (ii) **the environmental ethics i.e. water ethics**; and (iii) **the participants' ethics and values** – both the Mpophomeni enviro-champs and Vaal-Triangle primary school teachers. I must admit that had none of the participants raised any concerns regarding this matter, I would have treated the ethics of the study as 'business as usual'.

Throughout the findings and discussions sections, I focussed on exploring quotes from the research participants that address the issue of ethics and fairness, which really bothered me the entire study. I interrogated profound quotes from enviro champ Thandanani Luvuno especially from the question of, 'what do the participants benefit from this research', it questioned the ethical culture of the study and research in general. The depth interrogation looks at the tension between maintaining scholarly merit (being academically sound) and the social value of the study. To explore this tension, I considered various views: Mbiti (1969) and Mokgoro (1998) perspectives on ethics (cf. Chapter 3); the views from the participants about ethics and justice; and my own views and experiences as a researcher and a representative of institutions, i.e. Rhodes and GroundTruth. This kind of evaluation study requires a deep understanding of the context that must allow the participants' voices to be heard, respected and protected throughout the entire research process. I intentionally and openly address this tension because social and education studies like mine need to address these issues to reinforce true ethical and democratic socio-ecological transformation in the water management sector in South Africa.

I explored the quotes mostly that questioned the notions of ethics specifically when working with disadvantaged communities in South Africa – social (including institutional) ethics systems. Hence, I interrogate social ethics systems in the study that create the hidden substratum – thus generating the actual context. I further examine mechanisms that enable (or disable) the uptake and use of citizen science tools. Tilley and Pawson (1997) argued that realistic evaluation must explain such mechanisms that are sometimes hidden in social changes. It was essential to investigate social ethics because the study was developed and conducted under strict ethical conditions.

In this study and as a researcher, this innate obligation must guide decisions about research processes, policy analysis, participation, etc. Research participants must be given a fair platform for expressing their agency, ethos, values, and dignity. There are many ways to consider these, and I looked at them as social ethics systems that can be hidden or overlooked in philosophy, institutions and research processes. Because they are hidden and overlooked, they can easily inhibit the uptake and use of citizen science tools precisely in the contexts of the study.

Another challenge linked to studying social ethics or socio-ecological ethics, especially in research about Africans (South Africans included), has often been overlooked (Kruger et al., 2014). What has been observed is that these ethics are only considered when viewed from a medical health perspective. Consequently, the epistemology of these ethics and processes in the environmental field have mainly been explored with a medical health outlook as these dominate social ethics protocols in universities and research more broadly. Kruger et al. (2014) argued that the challenge of

understanding social ethics from a medical perspective only is not the sole problem. In addition, these social ethics have mainly been studied by non-Africans for non-African audiences. This was because often such research has relied on outside funding to help Africans, e.g. to improve health care and enhance knowledge of non-African organisations. They argued that the more profound challenge is that such research, in many cases, has left many African countries vulnerable to exploitative research (Kruger et al., 2014). They have failed to improve African lives and Africans have been expected to participate in ready-made research regulatory frameworks. These have left researchers inflexible in determining the research processes. Thus this study worked meticulously and with a depth of transgressiveness to interrogate and create a meaningful developing space for both research and participants.

Kruger et al. (2014)'s view helps create a different narrative about ethics. It gives a better picture and depth of where the *tragedies of inequities of ethics lie in African studies* – the tragedy about the hidden powers of limited access to choices or options. From a South African perspective and for this study, this view can assist in decolonisation thinking for human ethics in research needed when conducting water education and research. This is even more critical when involving research participants from underprivileged socio-economic backgrounds whose cultures and contexts are often overlooked and entertained at the periphery in academic logic.

While I was careful to follow ethical procedures of doing no harm, I found that it was also important to explore how institutional and academic protocol/ logic can have limitations and sometimes be unfair in terms of social ethics and for research participants. Institutions in themselves create particular configurations or 'situational logics' of both SEPs and CEPs (never separate in practice) (cf. Chapter 2) that set up differential power relations and shape the practical situations, daily experiences and events or happenings that individuals encounter (Luckett, 2012). When working with ethics, this is not an exception.

4.6. Scope of the study, research site and the selection of the research participants

As indicated in Chapter 1, the evaluation undertaken via this study was to establish who was already taking up and/or using citizen science tools for water quality management, and whether their uptake and use could bring about any form of **social change**, looking into their overall potential in water quality management, and what was working for whom under what circumstances and why.

The first research question was: 'Who is involved in the uptake and use of the citizen science tools and why?' This spoke to value, interest and benefit at the time of the introduction of the tools, during their

use, and with regard to the sustainability of the programme. 'Who should be involved for change/improvement to happen? And what are the relations between them?' This question determined the selection of the research participants in the two sites: Vaal-Triangle and Mphophomeni, further delineating the scope of the study. Hence the choice of all research participants was intentional to focus the specificity of the research objective.

As indicated in Chapter 1, the aim of selecting the Mpophomeni enviro-champs and the Vaal-Triangle primary school teachers was to see how and what the different contexts bring to water quality management and how the uptake and use of citizen science tools in these contexts bring in terms of social difference(s) and outcomes into the contexts.

The Mpophomeni enviro-champs case: the selection and categorisation of the participants in this case was organic. It was not pre-determined or stratified; rather it was a form of convenience and engagement based on those who were willing to participate in the study. Those who agreed to participate covered different age demographics and different roles in society and within families. These demographics brought different perspectives to how and why the uptake and use of the tools affected their socio-ecological, economic and political citizenship. The category included youths or young adults (18 – 35 years), middle-aged adults (35+), as well as senior citizens (60+). It also ranged from youths pursuing careers in the water sector, to youths buying time while waiting for better employment opportunities, to breadwinners, pensioners, as well as political activists. There were no female participants because the selection was based on the availability and willingness to participate. This does not necessarily mean there were no women in the whole project; on the days selected for the interviews, women were not present though. Even though concerns were raised from the men's point of view about how water quality and its management affected women more than men, the depth and breadth of such knowledge was limited. This study acknowledges its limitations, particularly the inclusion of women's issues that could have brought further depth and a broader understanding of the challenges, mechanisms and different perspectives to this evaluation study.

The study initially included only two enviro-champ group leaders (one from the first intake and the other from the second intake of the project). However, during a discussion with the GroundTruth team, it turned out that Mike Ward, also in the Environmental Learning Resource Centre, my colleague and a fellow PhD candidate at Rhodes University, was conducting a focus group study with the same enviro-champs group and the ward councillor. He was looking at different aspects of the enviro-champs project via the same organisation (refer to Appendix 8). It then became reasonable and fair

to consider ***sharing the data*** for this study to avoid duplication and overwhelming the participants with research interviews. This was strategically negotiated. We discussed which questions I would be interested in, and he asked them on my behalf.

The Vaal-Triangle primary school teachers' case: As in the Mpophomeni case, I had been provided with a list of teachers who had attended the ORASECOM workshop, and I only worked with those who felt comfortable participating in the project. During the visits (see Appendix 9 for dates and times of school visits), some teachers requested that we include the learners in the interview to hear about their experiences. But this would have been against the study's ethical protocol and the Rhodes University ethics (refer to Appendix 10). Including children under 18 years of age meant going back to the ethics board, so children did not become participants in this particular study.

At some schools, the principals did not participate because some were newly appointed and had no information about the project. Some had not attended the workshop and felt inadequately prepared to respond to the questions I had for them. The demographics of the teachers, such as their age difference, were insignificant; however, there were other differences which were more pronounced:

- There was a fair mixture of gender,
- Each gender and its socialised expectations of roles and responsibilities influenced their relation to the uptake and use of the citizen science tools,
- Upbringing influenced how they related to the uptake and use,
- How the school was located in the society and in relation to the Vaal River systems and Vaal Dam also influenced the uptake and use.

In this case, I intentionally interviewed as many teachers from the same school as possible to gather as much information and knowledge I could since the workshop had been conducted three years before the interview. Teachers thus needed to tap into that memory and those experiences, which several teachers explained was difficult. This was an important feature that project developers need to be more aware of, emphasising the need to evaluate the project during the project implementation in order to collect accurate information and explore mechanisms sooner rather than later.

4.6.1. An informed consent form

Sending an informed consent form and going through it with the participants was the contemporary academic ethical process to follow as a researcher in education and social research. The Vaal-Triangle primary school teachers were sent an informed consent form (refer to Appendix 6) via email that stipulated the study's description, procedures, risks, and expectations. I also carried a hard copy during

the interviews. During the in-person interviews, we went through the consent form and discussed its meaning. To ensure that it was well understood, I translated it later after the interview into vernacular (see Appendix 11 for different versions of transcripts). After going through the form I allowed participants to sign it as a demonstration of (a) understanding and (b) voluntary agreement to participate. The procedure I planned and followed was professional and academically ethical, being in accordance with the approval of the University and GroundTruth's ethical procedures. However, it was only after conducting interviews that I realised that the consent form did not actually holistically serve the purpose of enabling the participant to make an informed decision about participation; instead, it could be said to offer only partially informed consent (Bishop, 2009). By this I mean that although the consent form explicitly addressed the research expectations, the challenge was that it was only given from my point of view as a researcher and an academic. The teachers had their own expectations. For instance, they 'had hoped that my research would look into requesting that WESSA would create/provide a monitoring programme for them' (teacher pers.comm, 2016). Such are the challenges when it comes to consent forms and their processes. I realised that they can sometimes be one-sided, shutting down other people's opinions and subtly excluding any negotiation around the fairness of participation.

There are two tensions pertaining to explaining the one-sidedness of a consent form and its processes. On the one side, there is a researcher's pre-determined engagement with the participant, whereby the researcher decides what being fair is – based not only on their own opinion but also on the consensus and norms within the research community's description of what fair is. Another side to this is that a researcher might have an idea or vision of how research must go, but this does not mean that the process itself is static. Researchers do not always have the opportunity to discuss what is fair with the participant. It would be more equitable if the process was more malleable to enable these kinds of negotiations. As unfair as it may be, Bishop (2009) argued that it is okay for the consent form to be 'partially informed' because it is improbable for the researcher to have complete information on how the research will occur. Otherwise, there would be no point in conducting the research. Bishop viewed this partial consent as open-ended permission, hoping that the researcher would allow the participants to reflect in an ongoing way regarding their consent status. Hence, the process should conscientise the researcher to be responsible and have a duty to "engage in a reflexive and sensitive moral research practice" throughout the research process (ibid., p. 263). Thus, a **once-off consent process is generally not enough**, specifically when we consider that 'what' poses as 'risk(y)' is not clear. For instance, substantial risks like bodily harm are easier to see and foretell. This is in contrast to more sensitive and complex situations – like the risk of harm to one's **knowledge and integrity**,

which is something which participants are exposing themselves to and entrusting the researcher with. For example, in cases like (a): when a participant is unable to express themselves in a language they are expected to be familiar with; (b): when a participant does not have an understanding or knowledge of the topic which they are expected to 'just know'; or (c): when a participant is telling the researcher something negative about what other participants/actors/agents do. Sometimes, participants may consent to participate in the study based on their relationship with the researcher and assuming only he/she can use the information, but not consent the use of their information by a third party. The researcher would be able to read body language and emotions during the interview, which are usually not recorded for the third party (Bishop, 2009). The challenge was thus to manage these kinds of misinterpretations.

4.7. Data processing and analyses

4.7.1. Semi-structured open-ended interview and narrative analysis

Realist interview analysis in a programme theory assumes two outcomes. It advocates that teaching-learning outcomes and conceptual outcomes exist through theory gleaning, theory refining, and theory consolidation as iterative processes. Realist interview analysis also allows investigators to be reflective and heuristic in their approach to build up, confirm, or refine the theory (Mukumbang et al., 2019). As in realist research, this study has demonstrated that the critical component that enables such processes and the CMO configuration analysis was **the context** (i.e. individual, collective, organisational, programme and environment in the real, actual and empirical). This was because the context determined the relationships built and the interactions within which the programme was implemented. The context was at the core of the study because it determined what, how and why people said things during the interviews. It also determined what mechanisms the programme triggered, under what conditions, to bring about what outcomes. As mentioned previously, it was relatively easy to describe the CMO configuration but creating meaning from it was complex.

Archer (2013) (in Chapter 1 of *Social Morphogenesis*) argued that the **context cannot be taken for granted, specifically because it has history and inheritance (of the real, actual and the empirical)** that influence the outcomes and relationships of this 'rapid' social formation. Unpacking her claim was difficult, because histories and inheritances happen in different but interconnected ways, with some of them happening in parallel. For instance, in the case of the Mpophomeni enviro-champs – there was the political history and its inheritance; and the environmental issues history; and inheritance that influenced the reasoning and resources (real-hopes, actual-events and empirical-

experiences) of why they were participating in the citizen science projects; and how they influenced their hopes. The study has demonstrated how these are all linked (see Chapters 5-8).

The process of unpacking Archer's claim in this study required two intensive activities that needed to be carried out with great sensitivity: firstly, there was a need to unpack and appropriate that history and inheritance in their contexts; secondly, it was important to unpack such a history and legacy in the real, actual and empirical – in the context of structure, culture, agency and relations. Consequently, the role of the realist evaluation was then to articulate at least the basis of the generative mechanisms within these contexts, and how these were being informed by and were informing external social change or transformation and systems, to elicit the CMO configurations in the citizen science intervention. The interview analysis has demonstrated that the intervention did not operate in a silo but was an integral part of the broader social formation (see Chapters 5-8). It was necessary for the study to identify and articulate the distinctive generative mechanisms of activities and processes in the three contextual domains (the real, actual and empirical – refer to Figure 4.1 below – with their history and inheritance) that have causal powers exercised at any given place and time. The study aimed to at least uncover most parts of **the 'change' in the programme** because focusing only on one domain would give an incomplete picture (Archer, 2013). However, it was also difficult to say if and when something had changed, because change is a subjective and multifaceted process (e.g. political, cultural, economic, demographic, etc.). A large amount of change can also happen without anyone noticing – i.e. without full manifestation (ibid.). This is one of the problems of sustainability in a rapid social transformation. For something to sustain itself, it has to adapt; and any adaptation requires some form of change. Identifying this change in the real, actual and empirical can be tricky because change evolves and how it is viewed by different parties is subjective. However, subjectivity is something which is inevitable (ibid.).

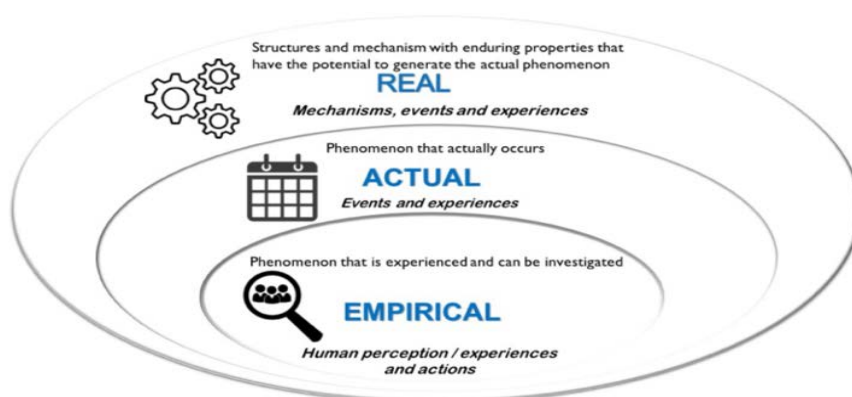


Figure 4.1: Ontological positions of realist philosophy informing realist interviews
(Mukumbang et al., 2019)

To avoid paralysis from subjectivity, the realist researcher has to start somewhere. I started by exploring and evaluating the assumptions and expectations of the project developers during the interviews, which was substantiated by the document analysis. I looked at their contexts and the contexts of the participants and the specific areas where they wanted the intervention. I then looked at the themes that emerged from working with the data and judged whether these themes formed part of the contextual and conceptual frameworks or the data analysis chapters – which allowed me to formulate which chapter of the thesis was based on the internal and external factors informing the intervention activity and processes. Most of the analysis focused on the subjects' interviews, as they were the project implementers, who were bringing different or new content and who understood the context of implementation best. Evaluating the intervention from the implementers' point of view was more fitting (in the real, actual and empirical) as it allowed me to understand the programme better than from the programme developers' point of view. Their perspectives were mainly concerned with evaluating a (programme) theory. As much as the realist evaluation is theory-driven, for instance, in how the questions were asked, the focus was not necessarily testing theoretical hypotheses on whether the theory is working or not. The main focus was rather about evaluating the intervention and the outcomes it brought about. The whole activity ultimately involved both the implementation and the theory (Mukumbang et al., 2019). There is a thin line between implementation and theory; however, in this study, **ethics played a crucial role in neutralising the situation** (cf. section 4.5 above). If my interests were to improve the theory initially, then telling the subjects to participate because I wanted to know if/how the intervention helped them or not would actually be deceptive and unethical. It would mean that I did not have the spirit of empathy and sympathy that enviro-champ Thandanani Luvuno (T. Luvuno, personal communication, February 12, 2016) had called for when it came to researching with or focusing on poor people. This would mean ignoring that poor people had their own agency; they do not sit and wait for researchers to do studies on them or prove theories on them. I was aware of the theory surrounding these preconceptions from the beginning and during the interview process, although everything became clearer when I discovered the theory-implementation interfaces during the analysis.

With realist interviews, it is never the case that a subject being asked a realist question will respond with a straight answer. And it is not always the case that when asked to list the outcome(s) of the intervention, the subject will go straight to listing them or recording how they are linked. This is because this kind of interview is a conversation, not a multiple-choice question or one that is concerned with right or wrong answers. Hence, as a realist interviewer, I needed to go beyond taking answers at face value. Instead, I always tried to find the underlying reasons or causal mechanisms,

sometimes even from other sources, to get to the meanings of what was being said. These causal mechanisms were either in the real, actual and the empirical. Therefore, analysis of the interviews was done in phases as in the sections that follow.

4.7.2 CMO configuration – a methodological approach for evaluating and analysing interviews

The process of analysis was complex but focused. I found it easier to get into the data but difficult to get out. To create a more effortless procedure to work with data, I used Table 4.1 that demonstrated principles for analysing realist/ programme theory data. I then used those principles to inform the colour coding in phase 1 below.

Table 4.4: Expansion of the formula of CMOs configuration according to different authors

[Key: **C** – context, **M** – mechanism, **O** – outcome, **SCAR** – Structure, Culture, Agency and Relations, **Rn** – reason, **Re** – resource, **SEP** – structural emergent property, **PEP** – personal emergent property, **CEP** – cultural emergent property]

Authors	Formula
CMO configuration by Pawson and Tilley (1997)	C + M = O
Programme and implementation theory by Weiss (1997)	Mechanisms (the response the activities generate) v/s successes and failures based of desired results
CMO configuration by De Souza (2013)	C + M (SCAR) = O
CMO configuration by Dalkin (2015)	C + M (Reason + Resource) = O
CMO configuration by Lacouture et al. (2015)	The vision = (targeted causal mechanisms (which are, according to these authors, close to the level of vision), theorized causal mechanisms (discourse) and observed mechanisms (arising out of practice)).
CMO configuration by Porter (2015a)	Programme (C + M (Rn + Re) + A = O) + Subjects (C + M (Rn + Re) + A (Collective/Individual) = O) + Issue (C + M (Rn + Re) + A = O) = O
CMO configuration by Archer (1995)	Hidden (SEP) (PEP) and (CEP)
Marchal et al. (2018) and (Mukumbang et al., 2019)	intervention-context-actor-mechanism-outcome (ICAMO) configuration
Notes: All of the above in relation to the following – ▪ Programme Outcomes are also influenced by = (internal programme activities + processes) + (external activities + processes) ▪ Programme developers' interpretation ○ the vision – the target causal mechanism – preconceived methodology ▪ The misconceptions ▪ <i>Informal community-based volunteerism outside of structures</i> ▪ <i>Formal community-based volunteerism within structures...</i> ▪ Integration - Bias - All doings and reasons have history and inheritance and influence the outcomes and relationships ▪ Subjects' interpretation ▪ The bigger picture: socio-economic and political view	

Table 4.4 contains descriptions of the mechanism(s) during the history of CMO configuration. According to the authors in the table, Mechanism(s), in brief, are the response that activities generate that can be structural, cultural, agential, and relational. A mechanism is a resource and/or reason hidden or noticeable in the real, actual and empirical. It can come from inside or outside of the programme and be of an individual or collective nature. Lastly, its manifestation can be unpacked when treating a context on an issue-based approach.

4.7.3 Analysis and coding

4.7.3.1 Coding the data

Analysis and coding of the two cases in this study differed, as I will explain in further detail below. The colour coding, phase 1, was kept consistent however in both cases. Table 4.5 below shows the colour coding approach used.

Table 4.5: Colour coding

Colours	Meanings
Yellow (Mechanism)	Number of times
Green (Mechanism)	Existence of something (e.g. structural)
Light blue (Mechanism)	Psychological, Cognitive, Affection, Physiological, Economic, Sociological, Economic, Sociological, Organisational processes 1. Amount of knowledge 2. Heightened interest 3. Motivations 4. Anxiety 5. Motivational responses Choices made
Dark green	Context
Red	Outcome
Purple	Programme activity

Table 4.5 above demonstrates, for instance, that the colour yellow is used to symbolise the number of times something happened in the intervention or the longevity of something happening in the intervention. Therefore, the mechanism could be the number of times the subjects did something in the intervention, resulting in the sustainability or success or failure of it. For instance, in Transcript 1 below, the parts highlighted in yellow, explain that the learners started to listen and act because the teachers repeatedly emphasised saving water.

Example: Transcript 1 (Please note the blue text is the translation into English)

Key: Researcher (R)

Teacher (T)

The interview was disrupted and now it continues...

R: Re tlo tswella mo re tlogetseng teng, kana ne re bua kang? Sorry ho distrurb mo hare ha all this emergency... (Both R & T laughs) [we will continue where we left off. By the way where were we? I apologise to inconvenience you during your emergency]

T: Maneng re bua ka di 2l ya coke akere [we were talking about the 2l...]

R: Ee question ele ya hore lona ko wokshopong keng se le se ithutileng sona se eleng gore le a se berekisa mo sekolong le mogae?[Yes, that question was about what were the things you learnt from the workshop that you can use in both a classroom and home]

T: Se ke arabile yone... ee setse kee arabile [I already answered it... I already answered]

R: oho ya di brick neh [and what about the bricks?]

R: Also what has the knowledge enabled you to do in class with regards to teaching and /or was there any changes that you noticed? Especially in the classroom?

T: Ee ke bone change after re tswa workshopong, like bana(I have seen some changes after attending the workshop) Like bana, bana ha o dula o ba bolelela ka ntho e one ba changer and ba bona gore Mam'o serious. Aka se re bolelle fela gore re ska senya metsi, re ska tshelana ka metsi. Metsi ke bophelo, without water there is nothing that we can do. [Yes, I did notice some difference/change after the workshop... you see when you keep telling pupils about the same thing over and over again, they too realise that I, the educator is serious. They will also recognise that I cannot just instruct them not to waste water, or to stop splashing water to each other. You see, water is life, without water there is nothing that we can do]

R: Mara kamo classing mola ne le rutang? Kana ne o etsang? Life skills? [please remind me, by the way what were you teaching? Life skills?]

T: Ee Lifeskills. [yes, life skills]

R: Mo metsetsing, ne oba rutang ka metsi [in life skills, which parts talk about water?]

T: Ne ke ba rutang ka metsi, eno ya gore ka bateng ba sebedisa 90 letres ya metsi and ka showering ba sebedisa probably 11 litres. Bana ha ba kgolwe (disbelief). Because ke nagana gore ha ba na di bata ko badulang gona. Bona kelello ya bona ene ele gore shower e senya metsi go feta bata. Ba nahanne e kare metsi ha a tswa jwalo in the shower, a ma ngata ho feta a bata. O bone classing, selemo se seng le seng ntse ke ruta bana classing, ba etsa strike. Ba re no Shower ke yone e senyang metsi go feta bata. Mara le ga o ka ba bontsha gore, mara ke sure hore. [I was teaching them about the difference of water use, whenever they use a bath tub to bathe they use 90 litres of water and when they shower they use 11 litres. Learners did not believe. I think it is because they do not use or do not know bath tubs in their homes. In their minds they think the shower uses more water than the dish. They think when the shower splashes water, the water released is more. You see every year I teach different learners; they still do not believe that showers save water. Even if you can try to demonstrate to them they still don't....]

R: Oh shower tsone di teng [but do they have showers?]

T: Habana tsone, moo for community Habana tsone ba ithapela ka di bata, ekere le di toilet di le kante. Ba tlhapele di vaskomong, so bona ka kellelo ya bona ba nahana hore shower ke yone e senyang metsi he antse a tswa. Ha ba nahane hore bata oa e bulela heo qeta o dule o emetse yone 90l ee. So bona ha bana tsone, maybe ba di bona Tv kappa ha ba etetse family tsa bona. So ba nahana hore shower e senya metsi wa e bulela then metsi a tswa shhhshhhshhhshhhh, ha ba hanahe hore bata ke e kgolo and e tseya metsi a mangata. Motlho o mongwe ga o ka bea metsi mo, a mongwee moo. Ba tla zama ho understand. [They don't have showers here in this community. They use bathing dishes to bathe. They even use outside toilets. In their minds it does not make sense for them to understand that a shower saves water, unlike in a bath tub where you have to wait for 90 litres to fill. So they make reference to the bathing dishes they use, because they do not wait for long. I think maybe they see showers and bath tubs at the relatives when they are visiting or on TV. So they still believe that a shower wastes more water especially with the sounds it makes when it splashes shhhhhhhhhhh. They do not think a bathing dish they use is that big to carry a lot of water. Maybe if you can put water in separate containers from these separate sources, maybe they will try to understand.

R: oh and another question, the knowledge that you guys acquired from the workshop, how long did it take you guys to use it?

T: ke sebedisitse for nako etelele, I think ke nako e telele.... But [I used it for a very long time... I think it was a long time..But]

4.7.3.2 Phase 2: Translating seSotho into English (see Appendices 11 for different stages of analysis)

The only transcripts that were translated into English were those from the interviews of the teachers, because the interviews were one-on-one and they felt free to speak in their own spoken language which is Sesotho. The interviews with the enviro-champs were conducted in English for the following reasons: (a) the other people in the interview panel could only understand English, (b) even during a one-on-one conversation I could not completely understand the enviro-champs' language, which was isiZulu, because I speak Southern Sotho/Setswana which are totally different dialects. However, I did notice that the enviro-champs were not as free to express themselves as the teachers had been, probably because of the language barrier.

Most transcripts were analysed without translation, because I realised often meanings were lost in translation, especially with direct translations into English. Where I managed to translate text, I would have to insert words that incorporated the body language expressed during the interview, because some meanings in the texts were incomplete or didn't really make sense without explaining what was going on at the same time. Another reason for not translating into English was because English has so many synonyms and choosing which word or term to use was difficult. This is the reason why some terms in the interview texts were used interchangeably.

4.7.3.3. Phase 3: Finding issues and their themes

This phase took different approaches for each case. Figures 4.2 and 4.3 illustrate two different ways in which issues and themes were drawn from the different cases.

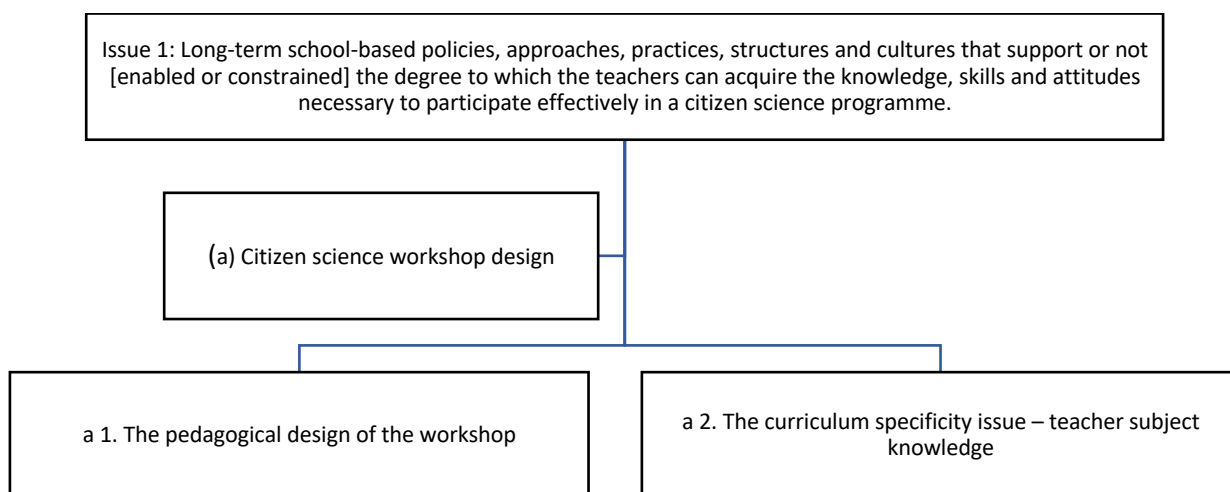


Figure 4.2: Example of unpacking analysis of the CMO configuration for one of the teacher's issues

The case of the Mpophomeni enviro-champs

Issue 2: Dealing with crisis in the citizen science project.

Context	Mechanism	Outcome (Individual or Collective)
From December 2013 and January 2014 no funding was available for the enviro-champs which then caused anxiety for them.	The verbal reporting on manhole spillages and blockages continued even though they were not documented → This emanated from choice and individual agency. This however affected the efficacy of reporting.	The enviro-champs could not print materials/forms used to capture data on manholes spillages or blockages.
Another stumbling event was in December 2015, when there was a very large decline in the number of reports.		When there was no funding there were no reports. Because there was no funding some enviro-champs left the programme and went to find jobs.

Figure 4.3: Example of unpacking analysis of the CMO configuration for one of the enviro-champ's issues

Figures 4.2 and 4.3 above show the different approaches used to analyse the teachers' and enviro-champs' cases, according to issues. In Figure 4.2, for instance, (a) citizen science workshop design was seen from three perspectives. It was firstly seen as a sub-context to a1 and a2 – structural conditioning for the citizen science practice introduction. Secondly, it was a mechanism – cultural emergent property – a belief or idea that after teachers interacted with the workshop design, they believed that enhancement through a1 and a2 could produce effective outcomes. Lastly, it was an outcome of the context of Issue 1. This ultimately leads to the realisation that (a), (a1) and (a2) can be mechanisms if strengthened.

In the analysis shown in Figure 4.3, red highlights denote context and can be seen in both the context and outcome. The context in the outcome column becomes a context of the new phase. Basically, an outcome of one context can form a new context of another – they are cycles, like the morphogenesis cycles by Archer (1995).

4.7.4. Triangulation: A complementary/supportive knowledge (s) system strategy for understanding and interpreting data in-depth in the issues and phases of this study

For a long time, the adoption of the 'triangulation' metaphor in social inquiries has been applied as a strategy for proving the validity and objectivity of the interpretation of data extracted from different methods/sources (Flick, 2004). However, each method is infused with a specific theory to unpack or measure a particular issue, and each method has its own context and agenda/process. It cannot easily be concluded that the methods are consistent or accurate with each other **BUT** what can be said is that each method or theory can be applied in a system. Together they strengthen the justification and confidence of data, increase the depth and breadth (implicit or explicit) of the issue under investigation to give a comprehensive understanding that they would not do on their own (Flick, 2004; Heale & Forbes, 2013; Knafl & Breitmayer, 1991). Triangulation confirms two ideas: one is that the whole is greater than the sum of its parts; the other is a divergence of findings. There were new ways to explain the phenomenon under investigation (Heale & Forbes, 2013). The central role that triangulation played was to neutralise bias and deepen interpretation. The main reason to apply it in this study was that **triangulation was found to be a core mechanism for the programme theory or CMO configuration theory to function**. For instance, to understand the context of the issue under investigation, one needed excerpts from the interviews/narrations and documents and to apply different theories to get to a deeper understanding.

Hence, the approach to how this study applied triangulation is as following (categorised by Flick (2004):

1. Through triangulation of different methods of data collection:
 - a. *Interviews and observations*. Taking notes of how the subjects expressed themselves during the interviews, in words, body expressions, and emotions. I have integrated this into the data interpretations and elaborated on their meanings.
 - b. *Document analysis* was also explained earlier in this section.
2. Through the expansion of theories (see Figure 4.3 above) to increase and gain multiple but complementary perspectives on the issue under investigation.

3. Through triangulation of data drawn from different sources, different times in different places and from different people.

4.8 Summary of Chapter 4

In this chapter, I outlined the methodological approaches that I used, through which I sought to find the depth and breadth in unpacking the mechanisms (both influencing and/or influenced by the internal and external AND the visible and invisible factors) when generating and interpreting qualitative data for realist evaluation or programme theory in the context of citizen science practice. Furthermore, I demonstrated how these methodological approaches influenced the analysis in each case to understand the uptake and use of citizen science tools for water quality management both contextually and in a system. I further defined the case study methods and discussed issues related to the quality of the study, namely ethics and trustworthiness criteria and approaches. The chapter also discusses the ethical culture of the study and research in general, acknowledging the complexity and sensitivity of ethics in social, ecological, and education research. It suggests that ethics in research involve both descriptive and prescriptive aspects, and researchers must find a fair balance between participants' views and scholarly merit.

The next four chapters of the thesis share the empirical analysis, with emphasis on contextual analysis (Chapters 5 and 7) and the relationship between this and the issues that shed light on mechanism and outcome configurations (Chapters 6 and 8) in the two case studies under investigation.

CHAPTER 5

CONTEXT OF THE VAAL-TRIANGLE PRIMARY SCHOOLS AND THEIR TEACHERS

5.1. Introduction

This chapter describes the context of one cohort of this study, the Vaal-Triangle primary school teachers. The chapter aims to describe the primary school teachers, how the citizen science intervention was set up and introduced, showcasing different reasons for the introductions from various stakeholders and how the tools and techniques were eventually adopted. It further describes the contexts of the schools, including the history of these areas and the surrounding water bodies where the citizen science tools were meant to be applied. The beginning of the chapter shares narrations by the teachers and principals regarding the context to ensure this was current and lived as described in the study. Unpacking these layers of contexts helps to reveal the generalised assumptions about implementing the intervention and to draw out reasoning behind constraining and enabling mechanisms and opportunities embedded within these contexts.

5.2. Introduction of the citizen science tools to the Vaal-Triangle primary school teachers

The citizen science tools were introduced at a workshop held during the year 2012/13 organised by Emfuleni Municipality through Metsi-a-Lekoa,⁴⁰ the municipality's business unit division that was established in 2005. The aim of this workshop was to **address better and easy ways of saving water** through the Boloka-Metsi (Save Water) project. Emfuleni invited ORASECOM through a consulting company, Water Resources Engineering, known as WRP, which was in partnership with GIZ appointed to conduct the Boloka-Metsi project.

Around 2012/13 period, the Boloka-Metsi project at Emfuleni needed to take this pivotal stride, based on the water reduction mission around the Vaal River systems and Vaal Dam because of the following reasons:

- Emfuleni is the biggest municipality in Gauteng with the major challenge of losing the highest rates and volumes of water in their internal system. This has incurred significant costs through leakage, wastage, infrastructure maintenance, internal leakages in the households.

⁴⁰ Metsi-a-Lekoa Unit is divided into Water, Sanitation, Maintenance, Planning and Projects, and Customer Services. It also has a social programme; schools programme; awareness and education programmes for the general public, including targeted programmes for different sectors e.g. religious, youth, etc.

- Urgent strategic repairs were necessary as well as building the capacity of the public/ citizens with different ways of saving water, and to address their water consumption patterns.
- It needed to address challenges that the Department of Water and Sanitation (DWS) was facing, e.g. integrated programmes of the Vaal River Systems.

It was essential to deal with these issues promptly because Emfuleni is regarded as one of the biggest municipalities after the metros in the Gauteng Province of South Africa.

Many different activities were offered during the workshop. In the project led by ORASECOM, who followed up closely with the participants, including the Vaal-Triangle schools, WESSA (as a supporting partner) aimed **to support people to engage with water quality issues at a local level** as a partner with ORASECOM implementing the River Learning Box. Some of the barriers that WESSA encountered during the workshop included:

- inexperienced educators who could not use the scientific tools optimally;
- language barriers;
- a lack of citizen science community of practice;
- people were unable to articulate water quality and quantity challenges.

The change WESSA wanted to effect depended on the expectations, particularly the objectives and challenges of the people/educators at a local level (J. Taylor, personal communication, February 10, 2016). WESSA introduced the citizen science tools to many educators who attended, including the Vaal-Triangle primary school educators.

The main reasons for primary schools being invited to this workshop were that Metsi-a-Lekoa, as part of its Education and Awareness programme, had partnered with certain schools around the Vaal-Triangle. Secondly, some of those schools already ran water-saving initiatives. Metsi-a-Lekoa supported them, especially in water harvesting projects and food gardening using Rand Water tapwater.

At that time, Metsi-a-Lekoa used to do excursions with the schools – taking them to Rand Water wastewater plants via the WaterWise programme so that the schools could experience and observe the processes involved in their water purification systems. Every year they used different approaches in engaging schools. Some years they ran poster competitions. In 2016 they were busy building the pressure station, and the idea was to allow the winning schools to paint the station as a prize. The whole point, according to Metsi-a-Lekoa, was to build and encourage young people to be involved in the issues of the WaterWise programme.

After the schools had been invited, they sent educators who were teaching environment and safety-related subjects, particularly those dealing with the water content. These subjects included:

- Grade 6 Natural Science,
- Grade 6 and 7 Life Orientation
- Grade 6 Life Sciences
- Social Science.

According to the educators' expectations, it was clear that the workshop was about awareness of water usage and where the water was coming from – and prediction of the future status of water availability.

5.3. Who and why? The introduction of the citizen science tools and the intervention to the Vaal-Triangle primary schools

5.3.1 Setting up the context

Firstly and foremost, like in the context of the Mpophomeni community enviro-champs, the citizen science tools were introduced as an integral part of the existing learning and teaching programme for the schools in the Vaal-Triangle area. The introduction of the citizen science tools aimed therefore to strengthen teaching about topics like rivers and their catchments in subjects such as Natural Sciences, Life Sciences, and Geography as articulated in the Curriculum and Assessment Policy Statement (CAPS) for the Intermediate phase and CAPS for the Further Education and Training Phase (Grade 10). The citizen science practice was assumed to be conducted through fieldwork experience and collecting scientific evidence.

The following section describes the context and environment in which these schools operated at the time (i.e. the year 2012/13) the tools were introduced.

Firstly, the citizen science tools were introduced differently to the way in which they were introduced to the Mpophomeni enviro-champs (i.e. ORASECOM workshop). Some tools were presented at a International citizen science workshop which occurred in February 2016, mentioned and analysed in this study (cf. Chapter 6). The citizen science tools were initially introduced to the Vaal-Triangle primary schools around 2012/13 in connection with a **Save Water and Sanitation Awareness** project. The service provider was WESSA (and ORASECOM) on behalf of the South African Department of Water and Sanitation.

The principals and teachers interviewed for this study were same participants from the WESSA/ORASECOM citizen science project. Thus these participants were expected to remember events that occurred almost three to five years previously. The project ran two years or less in different schools

after its introduction. Neither WESSA or ORASECOM, nor the municipality, had created a long-term follow-up culture/structure nor developed a monitoring and evaluation system to support the project. At the time of the interviews, the teachers themselves did not have documented evidence of the work done.

Hence this study acknowledged the possibility of insufficient data collection of all the activities taught during the workshop, and the case study relied on the information shared during the interviews.

5.3.2 Citizen science techniques introduced to the Vaal-Triangle primary school teachers

Teachers were requested to save water by applying the following '**citizen science**' **techniques** in their schools:

- ***Citizen science technique 1: Placing a brick into a toilet cistern to reduce the amount of water used during flushing***

Teachers were taught how to conserve water by putting a brick inside a cistern of the toilet. The aim was to reduce the volume of water used when flushing differing waste. For instance, one would flush once when urinating and twice when defecating. This helps release the appropriate amount of water needed during flushing.

- ***Citizen science technique 2: Hand washing bucket***

Teachers were advised to fill 2l/3l buckets with water and soap for learners to wash their hands instead of using running water from the tap.

- ***Citizen science technique 3: The shower-bath tub comparison methods***

It was explained how showering (7l) could save water compared to bathing (90l) in a bathtub. Teachers were encouraged to use showers more than bathtubs.

- ***Citizen science technique 4: Boil water before drinking***

Boiling water is good way of improving the quality of potable water.

- ***Citizen science technique 5: Installation of gutters***

Not all schools had gutters. Gutters are necessary for harvesting rainwater from the roof.

- ***Citizen science technique 6: Installation of JoJo tanks***

Only some schools had JoJo tanks for storing water.

5.3.3 Citizen science tools introduced

Unlike with the Mpophomeni enviro-champs, where many citizen science tools were introduced, the Vaal-Triangle primary school teachers only recalled learning about and working with one citizen science tool, the miniSASS.

▪ ***Citizen science tool 1: MiniSASS***

Most of the educators found the activity of MiniSASS interesting. They all understood that there is life in water bodies through micro-organisms; as a result, water bodies should not be contaminated.

5.3.4 After the workshop

Teachers who attended the workshop, especially those who were teaching Social Sciences at the time, benefitted through being empowered to:

- translate and integrate knowledge about what constitutes good and healthy water quality for potable water into subjects like Social Science (i.e. Geography and History) in topics about water diseases, e.g. bilharzia.
- internalise and personalise the knowledge about water flow in rivers and their catchments, through learning about the movement of water flow – from upstream to downstream, and the connectedness of rivers in the catchment which feed into the Vaal Dam.
- develop personal agency and accountability based on the realisation that the water flowing into their rivers needed to be clean because it was the same water they drank. Teachers of Human and Social Science, Grade 7, were encouraged by the CAPS curriculum to be informed of the natural resources, their management and conservation, etc. (Department of Basic Education, 2011).
- understand the water supply chain and water treatment process i.e. Metsi-a-Lekoa firstly cleans the water from the river or dam before sending it to their taps for drinking, and that water becomes more expensive to clean if not taken care of.
- knowing water-saving techniques learned at the workshop, enabled the teachers to have the courage and basis for disciplining learners when wasting water.

The beginning of the implementation of the project was effective because the information was still fresh, and the learners were enthusiastic and were able to participate with confidence in the classroom. They were encouraged by seeing the project facilitators from WESSA who visited them once after the workshop.

However, it was not clear who and how they benefitted from the project in the long term. One of the principals mentioned that he could not attest if the project was beneficial (to the school or any teacher involved): "I did not see anything [or any change afterwards- in a long-term]".

5.4. Context of the Vaal-Triangle primary schools

The name Vaal-Triangle initially covered Sasolburg, Vereeniging and Vanderbijlpark areas because they formed a triangle adjacent to the Vaal River (Bos, 1994). These included apartheid townships⁴¹ where the study's primary schools were located, Evaton, Vereeniging and Sebokeng townships. These three townships are among the Vaal-Triangle's five townships with a rich political history and heritage. Countrywide events from the 1960s onwards related to black people's resistance to white rule contributed to South Africa's political turnaround, for example, the Sharpeville Massacre of 21 March 1960 and the infamously violent eruption against rates and rent increases⁴² on 3 September 1984 (South African History Archive [SAHA], n.d.). This study takes into consideration the history that created the trans-generational political, cultural and social wounds and trauma, and how these contributed to the context of these townships, their schools and reasons (conscious and unconscious) for taking up (or not) citizen science tools.



Figure 5.1: Sedibeng District Municipality

⁴¹ Colonial townships – underdeveloped residential areas that during Apartheid were reserved for non-whites (Africans, Coloureds and Indians) who lived near or worked in areas that were designated 'white only' (under the Black Communities Development Act (Section 33). The invention was initially inspired by the colonial town planning found in many African big cities, e.g. Nairobi, Lusaka, DRC, Zanzibar, intended to intentionally and spatially segregate race groups, i.e. whites from non-whites, and class (Bos, 1994; SAHA, n.d.).

⁴² Rent increase was orchestrated by the apartheid regime manipulating black local councils and authorities, and the bantu administration system into collecting money from the communities. The residents protested and this developed into brutal violence spreading across the areas. These events affected perceptions and trust of councilors.

The townships where the study's schools were based were under the administration of Emfuleni local municipality, one of the three municipalities (the others being Midvaal and Lesedi) under the administration of Sedibeng District municipality (see Figures 5.1 and 5.2). Sedibeng is the fourth most significant contributor to Gauteng province's economy via manufacturing fabricated metals (iron and steel) and chemicals. Though Sedibeng is located in Gauteng, it is between the borders of Mpumalanga, Free State, and North West provinces. Sedibeng covers the Vaal River system, with Emfuleni sharing boundaries with the Metsimaholo local municipality (Free State) in the south, Midvaal in the east, and the City of Johannesburg to the north. This means that the Vaal River in Gauteng at the Vaal-Triangle already has three main stakeholders for managing its waters: Emfuleni, Midvaal and the City of Johannesburg – bringing complexity to the management of the Vaal River system. Furthermore, the Vaal River cannot be claimed by the Vaal-Triangle alone because of its interconnectedness to other water systems outside the triangle (Bos, 1994).

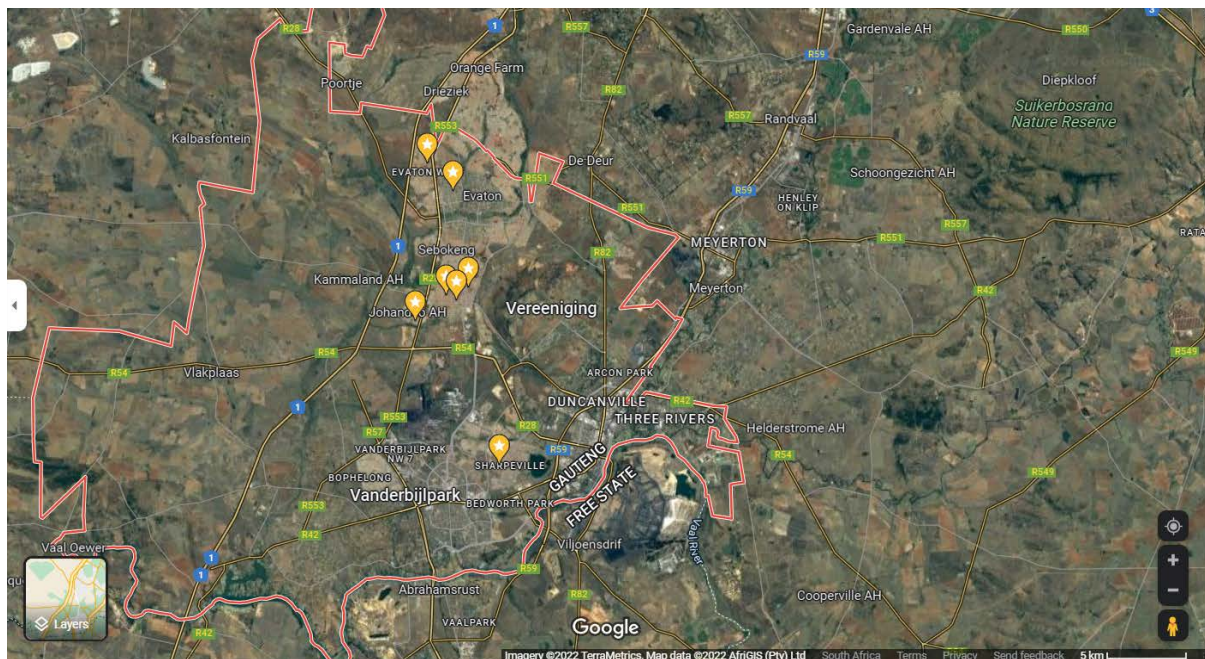


Figure 5.2: A map showing Emfuleni local municipality with the townships of this study, Evaton, Sebokeng, and Vereeniging

These townships are made up of low-income housing – RDP houses and informal settlements, Emfuleni being the largest in terms of population growth, with weak economic activities and high unemployment (Sedibeng District Municipality, 2021). It may be assumed that the residents of townships came from the same group or community or tribe (Group Areas Act, No 40, 1950), but this was not necessarily the case. Where there was a mixing of peoples, in many instances, this was because of forceful displacement, removal or dismantlement of families or communities – creating disgruntlement and sometimes tensions between individuals (ibid.). Moreover, the Group Areas Act

and town planning ensured that these residents did not own the land and buffer zones divided their residential areas (Pernegger & Godehart, 2007). Buffer zones were often natural resources such as rivers and industrial or commercial sites. Hence, "townships for African residents were areas of exclusion and control and containment of all aspects of the life of the residents" (Pernegger & Godehart, 2007, p. 7). Thousands of people were affected and had to normalise or live through and with these conditions. This context is pivotal to further explain the physical, social, psychological and relational reasonings as mechanisms and approaches for the teachers or schools to take up and use (or not use) the citizen science tools and their administrative processes.

Emfuleni, via the Metsi-a-Lekoa,⁴³ believed that *"lore lo ojwa lo sa le metsi, la omelela le a thaba"* (Metsi-a-Lekoa official, personal communication, September 12, 2016). This is an African proverb or idiom loosely translated as 'a twig is only malleable when it has been soaked in water' or 'it is easy to mould clay whilst it is still soft'. The meaning is that a child is easily disciplined or quickly adopts cultures or is better taught 'respect' at an early age because it is harder to do so when they are older. Hence, they selected primary schools to disseminate information about water conservation practices to the community.

Another principal aim behind involving the primary schools, according to Metsi-a-Lekoa, was to build and encourage young people to be involved in the issues of the WaterWise programme, which concentrates on reducing water waste and facilitating water efficiency. The concern raised by the teachers, which is also the interest to this study, was to find a monitoring and implementation system that can make this citizen science practice sustainable (Metsi-a-Lekoa official, personal communication, September 12, 2016).

⁴³ Metsi-a-Lekoa is a water services authority entity for Emfuleni local municipality.

5.4.1. The water quality issues in the Vaal Triangle community and the citizen science tools engagement

Introduction: The socio-cultural and environmental context facts before the intervention

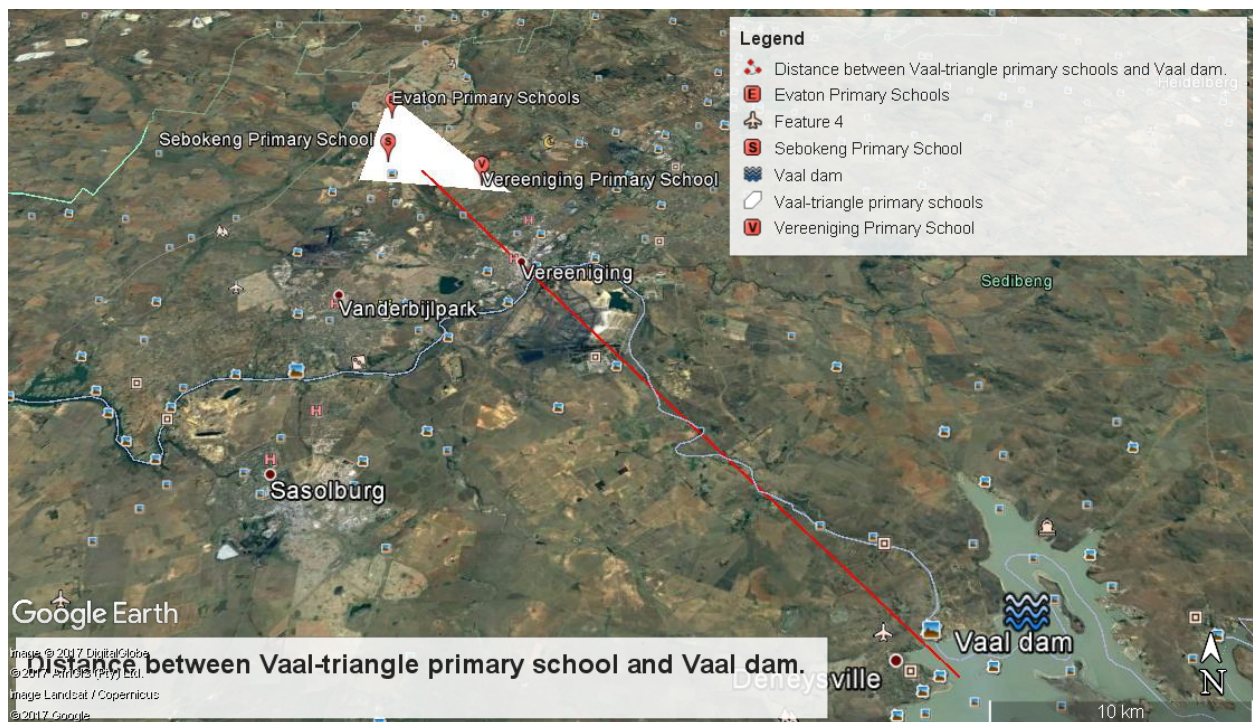


Figure 5.3: Location of the Vaal-Triangle primary schools in relation to the Vaal Dam

The average distance of the Vaal-Triangle primary schools from the Vaal Dam is about 42km (see Figure 5.3), with minimum elevation above sea level of 1414m, average of 1464m and maximum 1564m. This data shows that the depth of the streams is greater than those in Mpophomeni. This information was important background for understanding the uptake and use of the citizen science tools, particularly the difference between the distance of the study sites to the rivers and dam and their activities and relationships. Again, this information has been shown to affect the agency of the teachers and schools.

The citizen science tools for the Vaal-Triangle primary schools were used in a different way to the Mpophomeni case. Firstly, it was difficult to assign the primary school teachers the role of citizen(-ship) and thus it was difficult to ascertain the kind of participatory engagement expected from them. They play *multiple roles of citizenship* in this citizen science programme. Thus the study sought to differentiate the roles teachers played into three layers, and consider the expectations in each layer:

- as citizens belonging to the state by birth, who have full political, civil and social rights, e.g. they are all black South Africans,

- as citizens who are members of the state's organised personnel department, i.e. 'township' teachers,
- as citizens who sometimes differed in ethnicity (e.g. individual culture) from that of the schools they taught in. Some differed from the surrounding community's culture.

The three layers helped to understand individuals and the different impacts on the development of agency for participating in citizen science programmes like this study. They also enabled this study to trace the source of the mechanisms exercised or activated needed for participation in this study and determined the kind of participation required. Mostly, it was pivotal to understand their complexity and their relations to the context and figure out the relevant support mechanisms required by the teachers to participate and volunteer in the citizen science programme for sustainable development purposes.

These layers were not only useful for understanding the context of individual teachers but also there was a need to understand that these layers were embedded within different cultural and structural frames that determined when and how the teachers ought to participate. This complexity made these teachers' cases different from the Mpophomeni enviro-champs citizen science programme, which operated in a more fluid or open social/ community structure (refer to Chapter 7). These two systems (Mpophomeni enviro-champs and Vaal-Triangle primary school teachers) have different operational mechanisms which are affected by different constraining and/or enabling factors for the uptake and use of citizen science tools in water resource quality monitoring and management.

Water resource quality and water quality management related issues in the surroundings of the Vaal-Triangle primary schools before the intervention

Water quality in the Vaal-Triangle, specifically the Vaal River system, is *co-managed* (G. Maswine, personal communication, April 15, 2016; Metsi-a-Lekoa official, personal communication, September 12, 2016). The upper Vaal Dam was managed by Midvaal Municipality, and the lower part by Emfuleni Municipality. Midvaal Municipality was under the political governance of the Democratic Alliance (DA), and Emfuleni Municipality was under the political control of the African National Congress (ANC). It appeared the river systems under the DA were 'better' managed than the ones under ANC governance. This study did not delve into what entailed better management. However, these testimonies from the Emfuleni officers indicated opportunities for co-learning good practices should these two municipalities be given a chance to engage.

As mentioned earlier in the chapter, this study's primary schools were under the jurisdiction of Emfuleni municipality. The difference between Midvaal and Emfuleni was that Emfuleni mainly served a population of poor communities, informal settlements and RDP households (i.e. low-cost housing)

that were usually located further away from the Vaal River system riverbanks. The Midvaal municipality served more affluent communities and households (G.Maswine, personal communication, April 15, 2016).

The Vaal Dam has been polluted by return flow from sewage treatment plants and by underground mine water and effluent solutions discharged from industries (Ochse, 2007). For a long time now, Emfuleni municipality has been challenged by *degraded water quality*. This has been reported to Department of Water Affairs and Sanitation on several occasions. At times these state institutions were taken to the magistrate's court by community organisations such as 'Save the Vaal' for their *mismanagement* of water resources (G. Maswine, personal communication, April 15, 2016).

Some of the management challenges were that Emfuleni was partly responsible for some of the water quality problems because its mandate from DWS was to regulate only the distribution of potable water or blue water. Even more complicated was that Emfuleni outsourced the service provider, Rand Water, for potable water and associated quality management and distribution. As a result, Emfuleni was not responsible for regulating the water quality of streams or green water unless the source of the problem was only the sewage treatment plants. So their hands were tied in instances where the source of contamination was outside their mandate.

Another challenge that was clear from the Metsi-a-Lekoa point of view was that human capacity in managing water quality issues was insufficient (Metsi-a-Lekoa official, personal communication, September 12, 2016). As a result, they resorted to creating boundaries or areas of prioritisation for management. Concerning this study's interest, this prioritisation created the potential for an agency for public participation and engagement. At the same time, this allowed this study to explore the area of concern – the potential for citizen-state corporate management of water quality in formally disadvantaged urban areas. The aim was to consider the kind of platforms of participation and engagement that the uptake and use of the citizen science tools enabled or constrained for the citizens to raise their concerns and make informed decisions.

5.4.2 The background context of learners and communities in the Vaal-Triangle primary schools

Who are the Vaal-Triangle primary school teachers and the surrounding community through the lens of the teachers? The pre-existing cultural powers that enable or disable the intended mechanisms of change

The schools where the participant teachers were working are situated at Vaal, Sebokeng, Vereeniging and Evaton, which form part of the Emfuleni Local Municipality. They are located in the centre of the Vaal-Triangle's main industrial activities (McKenzie et al., 2006; McKenzie et al., 2012). Most teachers

were not from those townships, but were from nearby townships where public services were much better.

Unemployment and *poverty* were rife in these townships. Most of the learners come from broken families.⁴⁴ In some schools, the learners were raised by either grandmothers or young parents living in separate places. Parents were labelled as 'ignorant' in other families, especially in engaging and supporting school educational programmes such as environmental projects. In some schools, the issues were internal, for example, the school management structure was defective.

Sewage spills were rife due to the old malfunctioning infrastructure dominating the areas. Another challenge was that water quality issues were complex, and instilling good water quality management attitudes in the learners could not be seen as a panacea to emancipate the schools and learners (and the community) from water quality issues (teachers concerns).

The schools were located in impoverished and disadvantaged communities living in formal and informal settlements, often in RDP houses. The majority of the parents were unemployed and were young – many were in their 20s. Like other disadvantaged communities, living in informal settlements in South Africa, these communities were also not immune to young alcoholic parents and, in particular, young mothers who drink alcohol while pregnant (principal, personal communication, August 31, 2016).

According to the teachers' observations, most of the learners had psychological and behavioural problems, i.e. child-rearing challenges. Some of the reasons were that learners often came from *broken families* and did not live with both parents. Some were being raised by *only their grandmothers* who often could not help them with their homework. Teachers also noted that some learners were not psychologically, socially and academically able to study and they felt that these learners needed to be attending special schools.⁴⁵

Another challenge was that the parents of the learners did not participate in the school's other critical matters of concern except for issues that concerned the financial administration of the school, for instance, the school's financial budget and provision of textbooks. They were also not interested in the academic progress of the learners. The principal noticed that parents often showed no interest in school meetings. for. However, parents and the School Governing Body (SGB) prioritised matters

⁴⁴ Broken families refers to unhealthy or severed relationships within the family unit, for example, children been raised by grandparents where biological parents were not involved; single parents who surrendered to alcohol, drugs, etc.; few cases of child-headed homes etc.

⁴⁵ Special schools are schools catering for students who have special educational needs due to severe learning difficulties, physical disabilities or behavioural problems.

where political parties – DA, ANC and EFF – were involved. Hence there were no regular meetings for parents that concerned school matters and the school never bothered to invite them to meetings regarding water issues.

There were also issues about how the school management structures were operating. They were composed of the SGB which consisted of the parents, teachers, and peer staff⁴⁶. Every stakeholder involved in school matters ought to be represented. The principal explained that it was easier when they discussed school issues at the level of the SGB. However, it became challenging to disseminate such information to the communities (because of their disinterest and lack of education). Representatives were responsible for giving feedback to their relative communities. However, one of the principals, who was a bit frustrated, explained that the representatives do not pass messages to their communities but leave it to him to do the job on their behalf. He felt this was unfair.

Water issues in schools: One of the schools had a problem with their water pressure pump. The learners who were affected were in the foundation phase. They did not have access to water on many occasions, especially during the day. This was because many people in the community use lots of water during the day; as a result, there was not enough pressure to pull/push water to reach the taps where the foundation phase was located. This matter was raised with the school structure where the Department of Basic Education was invited, but nothing happened to resolve the issue. During the time of the interviews, they still had the same water problems.

In terms of issues concerning the miniSASS activities, teachers shared their frustrations about taking the learners to the rivers to create practical experiences for them. They mentioned that their rivers were deep and many could not swim, so it was dangerous for them to take the learners to the rivers. Another reason was illuminated by the principal in this quote,

You see, in most of the cases, once you say to parents that we are taking the learners to the river, they have so many concerns. Mind you, these are Africans, and they have their different values and beliefs attached to water bodies. They associate water with something else that I don't want to mention. But this does not mean that the environment conducive to teaching and learning where the interaction between teachers, learners and SGB is harmonious cannot work ... However, here it becomes even more difficult to call a sports day, it becomes difficult because there is a significant gap that exists between teachers and parents. So that is the fear everyone carries, especially about doing things not in the curriculum, such as going out of the

⁴⁶ Peer staff refer to the people working at the school who were not educators.

school premises to do experiments. Our teachers fear what and how parents would respond to that. The situation is just bad. (principal, personal communication, August 31, 2016)

Another reason schools had difficulty working with communities around them was that the platform that existed, such as community-based structures meetings, did not allow the teachers or principals to talk about the schools' issues. It was even more challenging to discuss environmental problems with the community because many were dumping waste illegally next to the school premises. The matter was raised with the SGB, but nothing happened to resolve it. Over a while, it became difficult for the principal to follow-up. He also felt that this responsibility belonged to the SGB, not him as a principal. He mentioned that "it is 100% the responsibility of the SGB, not the principal. The principal doesn't stay here; I am not a community member here..."

Following the above response, I probed how the surrounding communities were affected by the water issues and whether they had water quality issues or simply other issues with water in general. This was to explore what water challenges existed and how people perceived them. The principal replied by saying,

the surrounding communities don't talk [it could be that they are not courageous or empowered to question the government's authority] we have been given notifications from the municipality that shows a roster for water restrictions.... Even so, you don't always know [why we do not have access to water] ... if the water was restricted intentionally, or if the problem is pipe leakage somewhere, or what, you will never know. They don't even inform us on time. You only find out when you use the toilet when you want to flush or drink water from the taps ... then you realise there is no water ... and there is no reason for why. And it's frequently happening. Regarding the schoolyard's water quality, out of 100, I can give it 45% because I was told in grade R that some brown substances come out of the tap and are visible to naked eyes in a glass. We thought that since the school was new, it was built in 2011. Initially, we expected the pipes to be new; therefore, whatever brown particles came out from them were expected to disappear with time. But the problem persisted. However, since 2011 none of the school members, including parents or educators or learners, experienced any sickness associated with our water.

The teachers and the principals mentioned that often the schools give support to

"the workshops related to the curriculum, there is no teacher teaching that particular subject will be denied the opportunity to go and partake in that workshop. Because it will benefit the

teacher personal development, it will also benefit the school. In those cases, teachers **are supported 100%.**"

The teachers who attended the workshops were then allowed to give feedback to the school using any method they preferred.

However, if the workshop was not part of the curriculum or was an extra activity supporting the curriculum

What is left is for the people leading the programme or the project to do something? How will they push to make sure that what the teachers have gained from the workshop is implemented? In most cases, if you don't push people [i.e. the teachers], they will relax and remain where they are [they *become apathetic*]. For instance, in the workshop they attended, I cannot attest anything positive nor pin down what went wrong, some of the recommendations were not implemented. It means the project coordinators did not push enough, or maybe the teachers did not understand? I am not sure. But to a certain extent, the school supported them. At some stage, with the help of teachers, some of the learners produced a drama play where they performed issues concerning water. They managed to get position 2 or 3 in the competition. That shows that educators did understand at that time. They have also pushed in by implementing some of the recommendations from the workshop. (principal, personal communication, August 31, 2016)

The following sections 5.5. to 5.8 describe what is real to the Vaal-Triangle primary teachers in terms of public or civic participation in the decision-making processes linked to water quality management via the uptake and use of the citizen science tools, reflecting the pre-existing structural powers that enable or disable the intended mechanisms of change.

5.5. Reflections by teachers about the workshop in general and their experience of its impact

The teachers involved in 2012/13, when the citizen science tools were introduced, were teaching the following subjects and classes: Grade 6 Natural Science, Grade 6 and 7 Life Orientation, Grade 6 Life Sciences and Social Science.

The teachers felt guilty for not continuing with the citizen science techniques and tools activities. A year after their introduction, water problems continued to affect them, especially in schools. As one teacher said:

if there is no water, we cannot teach, because learners will want water to drink, water to flush the toilet, etc., ...so we end up releasing them [to go home, which then affect their learning program and progress].

Some educators asked if 'the WESSA people' are still coming back to pick up where they left off. Their reasons were that:

- They were taught one time how to conserve water and understood then. However, over time they could not carry on disseminating that knowledge because the schools and communities continued to waste water anyway.
- The schools and communities are becoming acclimatised (turning a blind eye) to wasting water and ignoring the threat of water scarcity.
- Lastly, the educators noticed that in the first year immediately after the workshop, the uptake and use of the knowledge of CS tools seemed to work. Learners were encouraged to participate merely due to the presence of the monitoring approach applied then; however, they could not tell **who benefitted at the end or who was continuing to benefit**.

The educators mentioned that they were aware of the water level decreasing at the Vaal Dam and acknowledged that it was a huge challenge that required all stakeholders to be involved. One of the educators had noted the efforts of the government (DWS) to address the water issues through media advertisements, but he felt there was still a problem at the grassroots level. Others also acknowledged Metsi-a-Lekoa's efforts to engage them with the WaterWise project whereby they are taken to Rand Water's purification station annually to see how water was purified – the trip excited the learners and made them participate inquisitively in class when water content was taught.

5.6. Citizen science techniques implemented immediately after the workshop that ceased after some time

Most educators implemented the technique of providing classes with a bottle or bucket for washing hands and drinking, either in their classes or lower phase classes, to avoid wasting water.

Most teachers experimented with the water purification technique using a recycled 2l bottle stuffed with different layers of soil types and sizes and materials to purify water. They took photos to create a profile; however, the pictures got lost.

Some thought about taking a few learners to the stream but could not because of the schools' learner safety protocols.

Most teachers, if not all, found the workshop interesting and fun, but the interest disappeared gradually over time.

5.7. Translation of knowledge about the uptake and use of the citizen science tools

Knowledge gained in the workshops increased some teachers' curiosity about life and biology in stagnant or flowing water bodies. Some of the teachers transferred this knowledge to children at home and at school.

Some teachers were able to apply the knowledge to other subjects, such as Mathematics, in a topic about mass (for example, teaching about the suspension of different weights in relation to their strength to resist gravitational force and using different sized stones in cooldrink bottles).

A challenge was that some educators used the knowledge and activities only when they were informed that programme coordinators would be visiting the school.

5.8. Activities implemented after the workshop and which continued to be implemented

Some schools bought JoJo tanks for water storage and these were still operational.

Some schools still used the water-saving technique which involved putting a brick in the cistern, which then reduced the volume of water being flushed out.

Some schools still use buckets for learners to wash hands and drink water.

5.9. Evaluation interests

The water quality management issues at the Vaal-Triangle primary schools are stratified merely because of their rootedness in different, sometimes fragmented bureaucratic structures at different levels. For instance, there were various stakeholders involved, e.g. DWS, the municipality, Metsi-a-Lekoa, and at the school level. It seemed the Department of Basic Education (DBE) was left out of the equation. The study found it interesting that each had different values, which were not always complementary though there still appears to be an overall interest in solving water quality issues. The circumstances and their dynamics prompted the study to investigate further how, what, and why the uptake and use of these citizen science tools are influenced by enablements and constraints, giving attention to the what, how, why and under what circumstances. Furthermore, the study was curious to find out the teachers' and principals' agency and determination in enabling and constraining the uptake and use of the tools. Of interest too was how all these factors of different levels and structures

interplay to improve water quality management through citizen science practice. These are discussed in Chapter 6.

5.10 Summary of Chapter 5

As shown in this chapter, the context of the public primary school teachers demonstrated different structures, cultures and roles played by direct and indirect diverse stakeholders with varying agencies and expectations for participation in the uptake and use of the citizen science tools for water (quality) management. As a result, some agencies and expectations were not adequately aligned and supported merely because there was no proper consultation mechanism for promoting democratic participation and engagement from teachers, where socio-ecological accountability would have been encouraged in the decision-making. Yet the teachers were the ones to implement the intervention and expected to produce positive outcomes. However, for a time the teachers were able to make efforts – for almost two years, i.e. the year the project was introduced and then the following year. After this, the momentum deteriorated. As explained by the principal,

For the first year it [the intervention] seems to be working, learners participated because there were facilitators who came to check the progress however I cannot tell who benefitted at the end because I did not see anything.... (principal, personal communication, August 31, 2016)

Furthermore, since there was no clear accountability and monitoring and evaluation of the response, over a longer time, the teachers did not feel obliged to implement the intervention. Hence, the intervention ceased in these schools.

Though the intervention and its implementation were ceased, this case was worth exploring due to its impact and potential to change the management of water from the school's perspective. It demonstrated the interconnectedness of layers that shape township public schools and suggests how to consider integrating them for effective public participation and meaningful citizen science intervention. In the next chapter, the study continues to unpack the findings from these contexts on an issue-by-issue basis. I look at what issues were revealed from what contexts and how they presented themselves in practice and implementation of the intervention. I also consider how they enabled or constrained the uptake and use of the citizen science by the teachers as well as the coherence of CMO configurations and implementation theory in this study.

CHAPTER 6

THE VAAL-TRIANGLE PRIMARY SCHOOL TEACHERS' CASE: ISSUES REVEALING CMO CONFIGURATIONS

6.1. Introduction

In the last chapter, Chapter 5, I unpacked layers of the hierarchical and historical systems that provided the context within which the primary school teachers could take up and use the citizen science tools. Here I unpack issues within those systems that enable (or not) the teachers to participate. These issues were hidden in the systems' structures, cultures, and agencies, and shed light on the CMO configurations i.e. the relation between context, mechanisms and outcomes.

These issues continue to showcase the extent to which the teachers' participation was democratic, allowing them the freedom to act on their agency and demonstrating who, in the end, bears the consequences. This makes their context much more complex than that of the Mpophomeni community (cf. Chapter 7). For instance, the chapter unpacks the ambiguous set-up issues from the onset of the introduction of the citizen science practice in the schools, such as the following:

- whether the workshop was designed for the pedagogical values of citizen science approaches to better teaching of or engaging in water quality issues in a classroom/ community at large,
- whether it was designed for strengthening participation or engagement in scientific literacy and competency (either for teachers and/or pupils) through citizen science values for their (i.e. teachers and pupils as citizens) emancipation from their socio-ecological ills, e.g. water resource quality issues.

As a realist evaluator, it was tricky to locate the approach as either a classroom education or a social or societal education activity or even a combination. The following findings dissected this complexity and responded to the puzzle mentioned above. I approach the findings using a focus on issues, and various dimensions of these issues as these seemed to best reveal the CMO relations in this study (indicated in boxes below each section as CMO Configuration Insights) in the sections below. These are discussed further in Chapter 9 and 10.

6.2. Issue 1: Long-term school-based policies, approaches, practices, structures and cultures that supported or did not, the degree to which the teachers acquired the knowledge, skills and attitudes necessary to participate effectively a citizen science programme

a. Citizen science workshop design, curriculum organisation and teachers knowledge

Apart from the trainers and government officials, the stakeholders who attended the workshop were the teachers and pupils. The workshop's design did not clarify the social role of the teachers and pupils or schools. In summary:

- The workshop did not clarify whether the citizen science skills and knowledge imparted were for the school at large as a form of a mechanism to disseminate information to society,
- Or whether the citizen science skills and knowledge imparted were for the teachers to influence attitudes and behaviours in the school about water use and water quality management,
- It was not clear whether the workshop was designed for teachers to teach pupils (identifying themselves as citizens) on how to become better citizens, and for the pupils to further advocate better practices for water resource quality management through citizen science tools,
- It was not clear whether the workshop was designed for teachers (who identify themselves as citizens or teachers or both) advocating teaching practices that promote better water resource quality management in a classroom, or
- whether the workshop was about supporting teaching better practices that influence pupils' perceptions and agency about social and environmental justice issues.

Teachers mentioned that they and the learners relied on ***the workshop(s)*** as a means (mechanism) to *reinvigorate their interest, information and knowledge about water quality management (outcome)*. Without the workshops, they would not have made any extra water-related efforts being preoccupied with other school-related issues.

- ***The pedagogical design of the workshop*** (mechanism) was insufficient to give support and capacitate the teachers for democratic participation in the classroom or schools

Teachers said that it was difficult for them to use and apply the knowledge and information acquired from the workshop in the classroom/school. The reason was that the knowledge and information were designed for social learning settings where there were no *confinements and regulations of the professional practice* as is the case for teachers, showing how the context influences the efficacy of the mechanism and thus the outcome.

Many teachers felt that such learning that happens through citizen science practice needed continuous follow-up, evaluation and monitoring; otherwise, it will not yield the desired outcomes – for both the project and teachers. They were searching for ***mechanisms of follow through***.

- **The curriculum specificity issue – teacher subject knowledge:** what subject knowledge does the teacher require to be eligible to attend the water resource and water quality management citizen science workshop?

Some schools selected teachers in economics, management sciences, languages, etc., to attend the workshop. But some felt the school should have selected teachers of subjects with specific water content. They felt that with subjects without water content they failed to relate the issues to their lesson plans. Moreover, during the teachers' feedback sessions, they thought they were not confident to report back about the workshop. This shows that **teacher knowledge is an important mechanism influencing outcomes**.

Another confusion the teachers experienced was that they could not figure out whether the citizen science programme had to be integrated into the schools' culture, the curriculum, or both. Teachers get allocated different subjects every year (i.e. subject rotation), which made it difficult for them to disseminate the knowledge from the workshop efficiently, indicating that **curriculum organisation is also an important mechanism shaped by context, influencing outcomes**.

Further insight into teachers knowledge as mechanism was related to public primary school educators not having **specialised knowledge for each subject**, and their **subject knowledge development being limited**. Consequently, they were limited to acquiring an in-depth understanding and establishing innovative approaches (i.e. limited outcomes).

CMO Configuration Insight 1: Teachers knowledge and curriculum organisation (context) needs to be more carefully considered in pedagogical design of workshops (mechanism) to foster more sustainable outcomes and better integration and uptake of CS tools in curriculum contexts (outcomes).

b. The bureaucratic demand for teachers' accountability limits learning and teaching in the classroom

- **South African Council for Educators (SACE) code of professional ethics for teachers**

SACE manages teachers via a code of professional ethics (mechanism). This management approach expected teachers to 'take reasonable steps to ensure the safety of the learner'. Although it was necessary, good and safe to minimise risk for the teaching and learning environment, it was at the same time constraining learners' learning development, especially in the context in which the citizen science practice operated (outcome). School management expressed their concern in allowing the teachers to take learners outside of the school premises to the Vaal River to gain real practical experience generated by the miniSASS activities. Again, few teachers understood the practical experience as beneficial to the learners. However, they were also conflicted about the children's safety (context) (as per the South African Council of Educators (SACE) regulations).

- **Union policies**

There seems to be a need for a mandatory review of the pre-apartheid and post-apartheid teachers' union policies (context) for reconceptualising their relevance and role in the democratic participation of teachers (mechanism). This is in order to mediate practical pedagogical approaches of engaging science education as a way to contribute meaningfully and responsibly to society (outcome).

Teachers explained that they are governed by trade unions that do not allow them to work on any day except schooldays. As a result, it was difficult for them to attend workshops during the holidays or on weekends. Furthermore, the challenge was exacerbated by the fact that if they attended the workshops that were not part of the syllabus during the weekdays, they needed to take into account that the attendance was at the expense of the pupils' learning programme. This is the case even when this supports the curriculum, such as the citizen science workshop. Lesson plans on a workshop day were usually lost. The only option was to attend workshops after school.

CMO Configuration Insight 2: *Union policies (context) need to be more flexible to allow teachers to participate more freely (mechanism) in activities such as CS workshops, to strengthen their professional knowledge and participation in use of CS tools (outcome).*

- c. **The absence or unclear guidelines of pupils' code of conduct, expectations and disciplinary measures or standards disable the pupils to reach their full potential in learning**

Some teachers, at some point, had been asked (by the school) to take pupils for practical work at one of the Vaal Rivers to learn more about rivers (structures and functions). Most educators did not see the trip as feasible because they had been observing the mischievous behaviour of "the learners of these days... the born-frees" (context). The lack of when and how the learners must be disciplined in schools made it difficult for them to make any decisions. What made it difficult was finding an approach to make them take responsibility (mechanism). They gave the example of "what if one learner pushes the other into the river and drowns? We fear such things, and our learners cannot swim" (context). This also explains the dangers of citizen science practice of this nature. Hence, consideration of the depth of rivers was necessary to implement this intervention (outcome).

CMO Configuration Insight 3: *Complexities of maintaining discipline and safety of learners (context) require tools and approaches to secure responsibility of learners and their safety (mechanism) to ensure meaningful participation in CS activities and use of tools at rivers (outcome).*

6.3. Issue 2: Lack of sustainable commitment and motivated teachers to integrate citizen science approaches into their classroom lesson plans

- a. **Despondency and lack of motivation by teachers**

Teachers did not continue with the workshop practice (outcome) because they were not motivated (mechanism) since the citizen science activities were not aligned with the subjects they were teaching (context) when the workshop was implemented. For those who taught relevant subjects, the implementation of the project was not long enough to keep them motivated (mechanism).

CMO Configuration Insight 4: *Alignment with teachers subjects with substantive support over time (context) can enable teachers motivation (mechanism) to continue with the intentions of the workshops which is to use CS tools more consistently in their teaching (outcome).*

b. The teacher transfer issue impacts the quality of teaching and learning in a classroom

The mismatch between the teachers' social background and life experiences versus the needs and experiences of the pupils/ schools needs to be considered (context). A challenge faced was that some teachers did not live in the same areas as the schools (mechanism). It was then difficult to relate to the pupils' daily water issues (outcome). The educators in the study area come from less disadvantaged and marginalised areas than the pupils. It was also difficult for them to provide the pupils with a sense of meaning that citizen science activities bring in the classroom. The circumstances of the teachers were mainly better than those of the learners.

One of the teachers explained an activity where learners were given scenarios about washing themselves, and they needed to demonstrate different methods that conserve water. The exercise involved comparing showering and taking a bath.

They demonstrated to us how showering (7l) can save water as compared to using a bathtub (90l). Learners did not believe it because they do not have showers [and could not relate]... they can only imagine water splashing from what is imagined as a shower. For them, they could only think it was a lot [just by imagining the speed at which the water splashes]....

The teachers who experienced challenges of water shortages in their upbringing in the villages were able to relate to the water issues at the Vaal. However, they needed skills and the approach to transfer that experience to the learners who did not perceive water as a scarce commodity. One of the teachers explained her frustration with the lack of good attitudes toward conserving water in her school:

I understand how bad it can be not to have access to water or even not to have access to good water quality because I am from the rural areas of Transkei in the Eastern Cape, and we fetched water directly from the streams ... And also, here in the Vaal, I stayed at the informal settlement for a long time. Not only did I live in an informal settlement where we had to travel miles to fetch water illegally from the townships. I would not want any other poor person to go through what I went through.

Through this lived experience (mechanism), her attitude and agency were different and more active. Besides being part of the citizen science project, she was further actively involved in entering competitions about water conservation topics in public primary schools. Also, despite the despondency, school politics and the socio-cultural-economic differences between the learners and teachers in the school setting, she still chose to encourage, connect and engage with her learners in a meaningful way – making the classroom learning fun, relatable and meaningful. Her background demonstrated how considering teachers' lived experiences could add value from the onset of making decisions and planning interventions such as this one, especially if sustainability and ownership are the ultimate goals.

On the other hand, other educators disconnected themselves from getting involved with the water issues in schools and were not even concerned because they did not want to bear the administration and financial costs (mechanism).

There is this crippled mentality of teachers that the workplace management challenges are not for them to care ... so they are not concerned nor bothered. I wonder if it is because they are not expected to contribute financially compared to their household? (principal, personal communication., August 31, 2016)

Another teacher mentioned that "Water is not a privilege or a right, but all people must have access to it".

Here, this teacher removes the responsibility and accountability from the teachers and addresses them on a systemic and structural level. She did not necessarily deny that access to water is a human right but implied that history has demonstrated that enacting laws to legitimise access to water as a fundamental to human dignity is not enough (context). And it has not worked for them so far in the townships. Instead, such laws are a 'band-aid' (sticky plaster) covering up what really needs to happen on the ground and what need to be invested in, i.e. ensuring sufficient infrastructure for everyone to access water. If there is only law but no infrastructure, then access to water for everyone is improbable, as is restoring human dignity. Then as a teacher, it is implausible for them to commit to such a law.

CMO Configuration Insight 5: *There is need to tap into teachers lived experiences (context) and support and motivate them to act on their agency beyond school practice only and connect this to life worlds of learners and real life situations such as material mechanisms of infrastructure and functional water supply system (mechanism) in order to address water quality issues in schools through CS tools uptake and use (outcomes).*

c. Lack of surrounding community cultural systems that can foster or reshape the 'environmental knowledge society and conscience' supporting the citizen science programme in the township public schools

Though they were primarily poor, the communities around the schools received reasonably clean potable water from the taps (context). The idea of connecting tap water to water sources had not yet developed (mechanism). Hence, comprehending the relevance and need for water quality management of the Vaal River and Vaal Dam was far-fetched (outcome). Therefore, developing an agency for the community to take any action and participate in the school's citizen science project was unfeasible at this point in time (mechanism). This situation then makes the aspiration for 'developing a learning society through citizen science' by Jim Taylor (the project developer) unattainable, at least in this context. In this case, for them to meaningfully participate, it required first a value proposition be negotiated for the Vaal River and Vaal Dam to the community beyond their presence in their vicinity.⁴⁷ This value proposition (mechanism) needed to make the relationship perceptible and would create processes for internalising their interdependence (potential outcome). The lack of such connections or associations resulted in the community not being concerned about water quality management (outcome). Even if there were concerns about water quality issues, they perceived them as not their responsibility (outcome).

Why would the community not be concerned? Even when the teachers described that the tap water contained 'brown things' visible to the naked eye. There were never any medical complications or deaths reported from the learners or staff, or the community in their response. Therefore, the assumptions were that it must have been safe to drink. Adding to this worrying perception was that one of the reasons the community may not be concerned was that they

... had access to electricity, RDP houses, clean water from the taps and flushing toilets that are regarded as the democratic basic human rights. And that was what mattered to them more than to be concerned about the environmental issues including water quality issues. (teacher, personal communication, August 31, 2016)

For this study (being evaluative and finding mechanisms for the uptake and use of the citizen science tools), these insights are disturbing, especially in a project aiming for social-ecological change. The last excerpt speaks to the basic need approach or the broader outlook of social and economic development (mechanism). It especially questions the method and process of the basic needs approach or its more general view on socio-economic development and its delusion about developing poor communities (Moller, 1985). However, it has its advantages as well as flaws. Though the study

⁴⁷ The Vaal River and Vaal Dam are known for fun activities such as canoeing, fishing, etc.

did not collect enough data to support the concern raised, it was essential to unpack this issue briefly since it was presented here. The question here was, what does this approach do to the community that affects their participation, responsibility/agency and support or lack thereof for the schools' citizen science projects' aspirations? Moller (1985) regarded participation in the context of basic needs in itself as being a basic need – i.e. a basic human right. It is critical to address this here because the success of many projects in the public schools is very much reliant on the surrounding communities' buy-in, particularly in environment-related projects (principal, personal communication, August 31, 2016). Also, addressing this issue here involves opening a dialogue on the participation challenges of meeting the SDGs and beyond if a study like this one does not critically address mechanisms perpetuating poverty – i.e. poverty as both a condition/mechanism (e.g. systemic) and a perception (Davids, 2010) – and how it affects development.

It is not the descriptive setting of the basic needs approach the study is concerned with but its implicit normative setting and expectations that disempower participation. Moller (1985) dealt with the following issues: the spectrum of what determines the minimum and maximum basic needs, short-term and long-term goals, satisfaction measurements, who decides what is basic and prioritisation, structural and cultural issues, evaluation and monitoring strategies, etc. in the basic needs approach – that have relevance to this section. However, as mentioned earlier, I focus on the implicit normative setting. Though it can be an implicit condition, it manifests in the physical through non-responsiveness from communities – alternatively perceived as 'not concerned' as alluded by the teachers. This is an example of going in-depth about circumstances that can constrain people from participating – in hindsight, interventions can perpetuate a cycle of poverty by depriving people of equitable space for engagement and participation.

Some teachers explained that the pupils lacked role models in their personal lives that could inspire them to uphold environmental values. They mentioned that

"Some parents do not care about water conservation practices."

"The reason why the learners don't practise or apply the water saving attitudes is because when they get home parents are not there to monitor them ... because they have jobs, again some pupils are coming from/are child-headed families."

And some

"Parents lack knowledge that is why they are not reporting leakages."

Environmental activism, like political activism, needs champions and radical revolutionaries to continue motivating communities and sustain the morale of the environment movement.

CMO Configuration Insight 6: *Contexts of poverty and exclusion may create a limited focus on ‘basic needs’ (context) at the expense of wider forms of possible participation, activism and engagement (mechanism) and may therefore effect the way in which people approach issues such as water, and water quality management that thus also the uptake and use of CS tools as people may perceive them as less relevant than other issues (outcome).*

d. Conflict of interests between teachers, school management committees, and political and personal issues in schools affect innovative approaches that are brought about citizen science practice

Some teachers felt that the school management and the teachers did not get along in many issues (context). For instance, the teachers felt that there were political and personal vendettas creating red tape from the school management committee whenever they tried innovative ways of teaching.

The leadership of public schools is invaded by the politics driven by political imperatives that have little to do with the realities of classroom life (Mouton et al., 2013, p. 36). This continues to perpetuate poor quality education. Hence, school governance systems need self-reflection on such opportunistic forces to self-guard their progress.

CMO Configuration Insight 7: *Negative school management relations and cultures (context) need to be addressed through improved school governance (mechanism) to allow teachers the spaces necessary for innovative teaching (outcome) that are needed for uptake and use of CS tools.*

6.4. Issue 3: Indirect challenges: A holistic view of reshaping collaborative cultural norms.

Fatal habitual activities can form an integral part of citizen science values (e.g. knowledge society) in water resource quality issues that limit the degree to which citizens can actively participate in water issues.

a. Lack of communication about water issues from the municipality constrains learning and teaching in schools

Communicating in time (mechanism) during a water crisis was a big challenge for many schools in the Vaal-Triangle area (context). They needed to engage in the communication guidance and advice strategies from the municipality to plan their lesson schedules properly (outcome). The teachers explained that they did not appreciate haphazard switching on and off of water without communication in advance or announcement. In many cases they were left in limbo without explanations.

One teacher explained the frustration:

if there is no water we cannot teach because learners will need water for drinking, water to flush the toilet, etc., ... so we end up releasing them [to go home, which then affect their learning program].

CMO Configuration Insight 8: During times of water crisis (context) it is important to communicate on time (mechanism) so that teachers can plan effectively, including for lessons related to uptake and use of CS tools (outcome).

b. Haphazard workshop planning for primary school teachers compromised the quality of the lesson plans and perpetuated passive learning outcomes of water issues in a classroom

Being a school teacher in public schools in South Africa in this socio-political and ecological era can be daunting. Almost everyone feels entitled to be involved in decisions regarding their professional development. At the same time, in many cases, the teachers' agency for growth or to do better is limited by rigid hierarchical structures and random political agencies. Even when the teachers raised concerns that most interventions are ineffective because they are not involved in the planning, and many are not self-initiated (Mokhele & Jita, 2012), these views continue to be overlooked (context). They feel they need to be met halfway. They mentioned that, after all, the curriculum administers their lesson plans. So if anyone introduces any workshop focusing on a specific content after it has already been delivered, then it will serve no value. Similarly, the citizen science workshop introduced the water issues content at a time when they had already passed teaching about them. They felt the workshop planners should have considered their teaching programs (mechanism). This would have made the teachers' jobs more accessible and usable, especially in teaching and preparing lesson plans (outcome). Advanced workshop planning would enable them to have time to deal with the content issue in detail and effectively (mechanism), unlike when the workshop is conducted after the content has already been delivered. Adding the teacher truths and the intervention truths leads to harmonising both worlds for better outcomes. Consideration of such contexts as an overarching conceptual framework that everyone agrees on peacefully for the betterment of quality education would make a difference in their professional development and classrooms – ultimately making interventions sustainably beneficial. Continuing such dialogues to make teaching and classrooms inhabitable for public school teachers is fundamental; if such considerations are overlooked, chaos is likely – because they have to be suppressed or are not allowed to exist in a manner they think is appropriate.

CMO Configuration Insight 9: *Addressing the problem of teachers being excluded from planning of interventions (context) through better collaborative planning and alignment with teaching programmes (mechanism) will enable teachers to better integrate planning of interventions such as uptake and use of CS tools in their teaching programmes (outcome).*

c. Fixed educators' job descriptions and expectations discouraged the uptake and use of citizen science tools

Teachers mentioned that the Integrated Quality Management System (IQMS)⁴⁸ appraisal, which identifies the weaknesses and strengths of their teaching efforts, determines what the educator has to do daily (context). The problem was IQMS did not recognise any work that the educator did outside of their job expectations (mechanism). They felt discouraged and trapped, and they could not 'go against the grain' of their teaching expectations (outcomes). This issue again adds to retention strategies needed to keep teachers motivated in projects such as this one involving citizen science.

CMO Configuration Insight 10: *Structural tools such as IQMS should recognise innovations such as uptake and use of CS tools, to enable teachers to include them in their practices and quality management portfolios.*

d. Lack of time management for natural science practical work and lack of understanding of the purpose to do practical work for science education by the teachers

Some teachers admitted that doing practical work in teaching “these water issues” in a classroom is difficult because of lack of time. A few also mentioned that sometimes it was because they were lazy to prepare. Preparation and execution of practical work required double-checking the facts and frequently referencing the learning materials (context).

Whether there is no time, a lack of understanding or teachers are lazy, all negatively impact immensely on the learning development of the learner (outcome). Practical work is a fundamental prerequisite to effective teaching and learning of quality natural science, especially for learners in primary school according to Curriculum and Assessment Policy Statement (CAPS) Grades 4–6 Natural Sciences and Technology (Bantwini, 2017) (mechanism). It is believed that practical work stimulates curiosity, critical analysis and autonomy, in learners by themselves (Bantwini, 2017; Festile, 2017). Teaching is at the centre of ensuring that such a premise is maintained. Water quality management issues are

⁴⁸ IQMS - Integrated Quality Management System for public school-based educators which is meant to evaluate the performance of educators, programmes and practices, with the intention of teacher development appraisal.

always going to exist in the lives of the learners, and introducing techniques that can help them early in their age is fundamental.

CMO Configuration Insight 11: *Time pressures and lack of commitment to preparation that are preventing planning and conducting of fieldwork (context) need to be addressed as part of professional development and practice of teachers (mechanism) to realise the benefits of such practices in teaching (outcomes).*

e. Lack of ownership of the citizen science programme

In hindsight, the kind of volunteering participation role each stakeholder is expected to play lacks a fair division of labour, *particularly when citizen science practice purports to be a 'democratic' collaborative effort.*

Teachers mentioned that any work done outside of their teaching syllabus in the classroom required regular follow-ups (mechanism). Regular follow-ups are difficult, particularly if teachers change subjects every year (context). Moreover, there was no monitoring and evaluation of the project. Whenever they were about to understand a subject, they were moved to either another class level or another subject. The system of teaching alternating subjects makes it difficult for the teacher to master the subject or content (context). As a result, nothing was possible to be monitored from their side. They thought they might have done this better (outcome) had someone from WESSA come to monitor the activity (mechanism). Without clear delegations of roles (mechanism), it was problematic to maintain the project's momentum. As one of the teachers said:

If something [outside the syllabus] doesn't get to be monitored or followed up; then the activity doesn't get to be taken seriously, it loses the momentum and the interests fade away with time. ... I still have that passion to continue encouraging other educators. Still, there is no follow-up [systems/structures put in place], so I cannot see the end of my efforts. As educators, the water issue required us to sit down and discuss it as a subject of profession and an initiative ... So it was just awareness. There were not really enough learning materials. I would advise the basic education system to allow a system whereby educators become experts in the subjects because when the workshops like this happen, they will be building on what we already have. The problem is that sometimes educators who go to these workshops don't teach the subjects dealing with the issue at hand. Taking new educators for an ongoing workshop will result in regression because you have to start afresh all the time. And by so doing, you are not building, or there is no development. The constraints mentioned about

teaching this water issue into subjects are similar to how the matric educators affect the results..... (Teacher A, personal communication, September 1, 2016)⁴⁹

CMO Configuration Insight 12: *Lack of continuity in teaching of subjects (context) affects teachers commitment to teaching, which is exacerbated by lack of follow ups from intervention teams (mechanisms) which affects effective uptake and use of CS tools (outcomes).*

6.5. Issue 4: Sustaining citizen science practice and its knowledge in the public primary schools requires human capital, human resource capacity building and empowerment; institutional and cultural strengthening; and economic capital

Under this issue, some findings required an in-depth understanding of the teachers' concerns. Teachers questioned the aspects of citizen science practice and its sustainability in the public primary schools.

a. Making the learning materials and citizen science tools available and accessible

The teachers mentioned that the workshop did not provide sufficient resources – the learning materials and citizen science tools to deliver instructions (mechanism). As a result, sustaining the knowledge gained during the workshop (outcome) was impossible without them. Appreciation of the concepts and interpretation of the content in the citizen science teaching and learning is a continuous process that requires activities and tools to reinvigorate and shape citizen science practice, keeping it alive and relevant. Hence, with time the knowledge gained faded away (outcome).

b. Making the learning materials inclusive to other class levels

Another concern discovered about the learning materials was that they were not *inclusive enough to be relevant for the syllabus of different class levels (grades)*, especially classes at a lower level. Teachers mentioned that materials were limited to Grades 6 and 7. They needed the flexibility of the content to suit their class rotations (mechanism).

CMO Configuration 13: *In contexts where resources are not plentiful (context) there is need to provide adequate resources, and to sustain their use, and ensure they are appropriate for the level of teaching (mechanism) to ensure flexibility, sustained knowledge uptake and use of CS tools (outcomes).*

c. What criteria are eligible for primary school teachers' participation?

Some teachers who went to the workshop were not teaching natural science at the time. Instead, they were teaching languages. They felt that since language subjects didn't have water content in their syllabus, it was not easy for them to integrate it. This raised two interesting perspectives about the

⁴⁹ Teacher A is from Primary school 3 in Sebokeng (refer to Appendix 7)

eligibility criteria for primary teachers to participate in the citizen science practice – one is about the relevant subjects they must teach. Secondly, there is the question about the kind of motivation teachers must have to participate actively and stay in practice, particularly if the subjects taught are not aligned with the content. Alternatively, it is necessary to assess *what informs participation* in citizen science practice, in cases where some teachers were not environmentally ethically bound or subject bound or do not value water issues.

CMO Configuration Insight 14: *Since teachers are teaching subjects that they are not always qualified for (e.g. teaching English instead of Science) and since water issues are not integrated into all subjects (context), there is need to adequately assess, align with, and support the kind of skill specification related to subject content, environmental ethics, and long-term participation expected from teachers that ought to be integrated into citizen science projects (mechanism) for meaningful uptake and use of CS tools.*

d. The citizen science project needs a monitoring system in the public primary schools

The educators wanted a system whereby they could make reports, give feedback and attend workshops to keep the momentum of the practice (mechanism).

e. The citizen science project needs the school management's support to encourage the citizen science teachers

The school management sometimes did not support these initiatives, specifically that they were not compulsory to the curriculum (mechanism); as such, the educators felt discouraged (outcome).

f. Teachers need to be empowered with competitive skills, both professional and scientific, to acquire the confidence necessary in the citizen science projects

Teachers lacked workshop evaluation, feedback and reporting skills (context). Also, the workshop reporting system available for them in schools was experienced as an afterthought and was ineffective (context). For example, they were only offered an afternoon slot when most were fatigued and unable to engage critically. Matters to be engaged included the following: their observations, discussions on workshop design, workshop content and relevance, usefulness and usability, degree of a confidence booster, strength and weakness in teaching approaches, external support, moderation etc., and these are fundamental points needed to improve their professions for the project developers to consider (mechanism). They help to respond to the concern about how valuable and sustainable workshops can be in contributing to professional training of teachers. The study emphasised these aspects because, as a qualitative evaluator, there is much literature about teacher professional learning workshops evaluation (Ahadi et al., 2021; Bantwini, 2017; Belluigi, 2015) but less focus on evaluating teachers' evaluations of teachers' workshops. Thus there needs to be space for teachers' voices about

how the workshop could work for them (mechanism); they need to be able to voice their needs and agency, which will increase teachers' ownership participation, and allow reflexive critical engagements to improve the workshops, etc. (Belluigi, 2015) (outcome).

CMO Configuration Insight 15: *There is need to address the poor management support and lack of skills in reporting, workshop evaluation and feedback amongst teachers (context) to strengthen and more fully engage teachers reflexivity and skills in co-constructing how the CS workshops can work for them (mechanism), in order to ensure their ownership, participation and reflexive engagement in CS tools uptake and use.*

6.6. Issue 5: Establishing a 'knowledge/learning community' for citizen science practice

This section presents and discusses mechanisms that can reshape radical participation and transgressive and transformative collaborative cultural methods or activities to give the citizen science practice the advantage.

Firstly, in the context of these schools modifying the concept 'knowledge/learning society' to 'knowledge/learning community' was fundamental (context). Jim Taylor, the citizen science project developer, aspired for these communities to develop a knowledge/learning society. This is a good intention, but is limited in scope. The concept of society is wider and more heterogeneous than the community. It constitutes a web of interactions of small communities, e.g. industrial society.

In contrast, a community could mean a group of individuals or families perhaps residing in a specific geographical area, physically or virtually, and they could be sharing the same interest, practice, circumstance, action and/or place. Its smaller nature means recognising small intimate interactions (e.g. moral or ethical considerations beyond oneself) between humans, non-humans and other lives – in the past, present and future – their agency, responsibility and determinism. These schools' systems were operating at this level (mechanism); hence the concept of 'community' is most fitting for this section. And 'the community concept' is in accordance with the philosophy of ubuntu in particular in terms of its intimacy of the pronoun "I" (i.e. *ngumuntu*) in others in the phrase 'I am because we are or a person is a person because of others' (i.e. *umuntu ngumuntu ngabantu*): the "I" which is in unity with others; the "I" as a composite of the past and the dead (e.g. history – totems), the people and the nature [ecology] it carries; and "I" that is considerate of the future. This I is not as individualistic as a pronoun in the English language. The I in this study's setting is demonstrated when the teachers' and schools' agency and responsibility were very much interdependent with the community's (outcome). Therefore, discussing the significance of ubuntu religion (from Mbiti's view of ubuntu as religion) recognised by and encapsulating the teachers in the citizen science practice was critical. This practice is in itself required for this kind of a community to function.

At this point, the study identified that a kind of community is needed for effective citizen science practice in public schools (mechanism). It further determined that the intervention lacked clarity on the type of learning outcomes or outputs that the schools or teachers were expected to produce. In particular, there was no clarity on what outcomes were expected for the teachers' learning development goals, school learning development goals and community learning development goals. At the same time, the study revealed that improving awareness and changing attitudes toward citizen science practices, the schools' politics and cultures could not be divorced from the community's politics and cultures (outcomes).

CMO Configuration Insight 16: To address the problem of too wide an ambition (i.e. society wide) for CS tools uptake and use at the practice level (context), there is need to develop a more realistic unit of analysis and intervention at school-community level. This means that interventions for citizen science teachers need to integrate whole school teachers' cultures, include strategies to engage the entire school's buy-in, and then the processes to engage the surrounding communities for the project to be meaningfully beneficial – a holistic community view is needed (mechanism) to facilitate meaningful uptake and use of CS tools.

So far, this section has selected different mechanisms bringing together different attitudes, behaviours, and social (cultural and institutional) processes that need to be changed, transformed or reshaped to understand better and enhance the uptake and use of citizen science tools for better management of water quality in both the schools and the community contexts, hence the title of this section is 'establishing knowledge/learning community'. Establishing a knowledge/learning community was necessary for this study as it was evident that these primary schools were a 'tiny incapacitated microcosm' that could not alone carry out the objectives of the citizen science practices. Also, even more importantly, identifying everyone's role and responsibilities was fundamental.

The following issues are based on the above premises about establishing the knowledge or learning community mentioned:

- a. **Challenging or shifting the conventional expectations of gender traditions and perceptions in communities can help in improving the role of citizen science practice in public primary schools**

Some teachers recognised that specific water issues affect different genders differently. Moreover, certain water issues activities were more associated with one gender than the other. For instance, some teachers mentioned that:

"People who fetch water are women [meaning they understand water issues better than men]."

"We have few men, four out of 20 or so educators in our school. We [men] are assigned to lead sports activities at the same time lead water issues, so it is difficult to manage [as men]. Most educators are female, and sports activities are expected to be led by males. So we are not balanced in terms of roles and responsibilities."

"Female educators do not care about the [technical aspects of] water issues in our schools; they are only concerned about their households' water issues ... they are always the first to leave school every afternoon... They [the same female teachers] have water taps in their households, and whenever there is a leakage [in their household], they will report it, but in schools, they don't."

These quotes speak to the issues of the role of patriarchy, feminist identity and masculinity and recognition of shifting and distribution of gender roles in communities and societies in general that influenced participation in the uptake and use of citizen science tools in schools. Thus, there was a need to redo and undo the internalised and socialised gender roles to enable optimum participation from all teachers.

b. Restoring the ubuntu beliefs and practices in schools and communities can help establish water conscious communities and water conscious schools

Some teachers were concerned about how the culture of ubuntu is diminishing for many teachers and learners, specifically regarding environmental issues.

You know, the learners of these days... the 'born-frees'⁵⁰ [followed by a body posture and facial expression indicating some degree of controversy to the concept]. Thus, in this instance, the born-frees meant the unrulable those who no longer hold the olden ways of conducting themselves, e.g. respect for the elders.

The above quotation was extracted from the context of the difficulties teachers encountered in finding alternative approaches to disciplining learners. All they knew were the old ways of disciplining children through whipping – 'you spare the rod, you spoil the child'. Since whipping, perceived as either corporal punishment or disciplining, was abolished in schools and it was the only cultural practice for disciplining children that teachers understood, they felt stuck. Without this disciplining mechanism,

⁵⁰ 'Born-frees' in popular political belief are youths born after the end of Apartheid era (1994) and enjoying the benefit of democracy, including freedom of speech and expression. This notion culturally is believed to subtly promote and condone disrespect of youths for elders.

learners were experienced as ungovernable and disrespectful. The issue of corporal punishment is serious and complex, however.

It was vital for the government to provide alternative discipline strategies for schools. Without them, teachers felt they could not reinforce ethical principles (even developing them is hard) important for the success of many interventions. Also, because of the blurry discipline protocols (codes of conduct), learners misinterpret and misappropriate the notions of being 'born-free' and children's rights and responsibilities. The Act linked to the latter advocated for legal protection of children without promoting children's responsibilities, e.g. respect for the elderly. This lack of respect for the elderly paralyses teachers who felt learners use this skewed view to their advantage. Teachers, as agents of authority and knowledge, were also elders.

Establishing discipline strategies for learners was in accordance with the belief of Emfuleni via the Metsi-a-Lekoa in the importance of establishing *conscious discipline cultures or water conscience cultures* in the primary schools to achieve a sustainable enculturated citizen science lifestyle. They noted that

“lore lo ojwa lo sa le metsi, la omelela la tlhaba.” (Metsi-a-Lekoa official, personal communication, September 20, 2016)

This is an African idiom, directly translated as 'a twig or clay is only malleable when still young or soft respectively, otherwise, once it gets hardened it breaks instead of bending'. It is usually used synonymously with 'you spare the rod you spoil the child', which means that a child is easily disciplined and taught respect when young rather than as adults. In this study, this is linked to respect for water. This is why Metsi-a-Lekoa chose primary schools as a mediating tool for disseminating information about water conservation practices to the community. There was a belief that children could 'sponge' knowledge and training, and through them, the community could change; however, without this respect, all efforts would end in vain.

Overall, these traditions form eminent fundamentals for instilling practices that can create a meaningful socio-ecological footprint of citizen science practices in the public primary schools. Upholding these could help in establishing knowledge and learning communities. Respect for the elderly and nature is a start.

c. Addressing and developing prevention measures for crime and security crises in township public schools must be prioritised

Teachers mentioned that their learning materials, including pamphlets provided during the workshop, were stolen a few weeks later. Considering that the uptake and use of citizen science tools relied on those learning materials, there was no way for them to continue with the programme. Crime in schools should be taken seriously because it is not only the daily operations of the school that are affected; the quality of the whole education system is in jeopardy as is the socio-ecological justice system. Therefore, putting safety and security measures in place is not only important for enabling access to conducive learning and teaching environment but also must be seen as an enabler to accessing socio-ecological justice.

d. Finding ways to work together with spirituality, myths and taboos to foster efficient citizen science practice to strengthen the sense of meaning in schools and the community

Teachers admitted that

As teachers, we are scared of water bodies [specifically massive ones] because we have our myths about water bodies as black people. We believe that gigantic water snakes live in big waterbodies that could make people disappear when they interfere with their habitats, even doing little things like entering into the deep dam and rivers.

These teachers' sentiments share the same beliefs as some black communities who believe that big water bodies [the Vaal Rivers and Vaal Dam are considered big] are sacred and should not be interfered with. This belief needs to be taken seriously in this context. Whether some beliefs were false and mythical to create fear in communities as the approach to conserving natural resources or spiritual beyond our everyday comprehension is not of concern – they exist and influence how some teachers and communities behave. The teachers in this study carried these beliefs and believed that the community around the schools had similar conceptions. These beliefs could be seen as a mechanism for impacting the success of the uptake and use of the citizen science tools in schools. Unpacking such beliefs can help create a knowledge and learning community around the issues of water as aspired to by Jim Taylor.

e. Fostering environmental care within and between the community and the schools can help develop sustainable classroom-to-home environmental practices

Most teachers believed that the community around their schools did not care about their affairs, including environmental and water issues. Their view originated from observing the learners' behaviour over the years which they believed reflected the communities they came from. They thought that the success of environmental projects was reliant on how learners were raised in their homes. Learners' attitudes and behaviour seemed to indicate a lack of care by the community.

Teachers felt that instilling and sustaining environmental values in learners was not possible without the community's help.

The above point was intriguing to this study, particularly in terms of developing agency between the home and classroom in fostering environmental ethics and learning. Whose agency has to be developed first, and how? Since citizen science practice and its values were introduced to the schools first in this project, what were the community's expected reactions and participation? This question is fundamental to the evaluation research to unpack the responsibilities of identified stakeholders to achieve the project's anticipated outcomes.

The teachers from one school further mentioned other concerning attitudes – the surrounding community was constituted mainly by very young parents who were perceived as 'irresponsible', poor, unemployed, and living in the RDP houses. Before the RDP houses, the area was an informal settlement. They mentioned that the community around the school tended to cause conflicts if the school donated funds to poorer families to support learners. They felt they all deserved donations. This was a challenge for the schools, and dealing with such mentalities negatively affected any progressive school interventions, including the citizen science project. The schools were facing issues of poverty, lack of interest, environmental issues and improving quality education simultaneously, without enough resources and capacity.

f. Political deployment of government department officials of the cabinet affects the performance and implementation of the policy on the ground

The teachers raised concerns and recommended that the political party and government must deploy a Minister of Water and Sanitation who is knowledgeable and competent in the field. Otherwise those on the ground suffer the most. They mentioned that knowledge and competence must be the fundamental qualifications beyond political affiliation. Without these, the efficacy of implementing the policies on the ground is negatively affected – precisely where they need teachers to be involved.

Teachers further mentioned that being inefficient and lacking progress with implementation of environmental projects such as the citizen science one begins with the lack of relevant capacity and passion from above, i.e. from the higher levels of government administrative management in the environmental sector. This is how it affects them, according to one of the teachers:

Haphazard changing of cabinet ministers and deploying people from different fields to lead the environment and water sector is not right. For instance, if you employ someone from the police force to run the environmental and water sector, the sector is bound to fail. You need to employ

someone who loves the work and has experience. In that way, the person employed will ensure progress and invest time and efforts to make effective awareness programmes. (Teacher A, pers.comm, September 1, 2016)⁵¹

What happens at the top of the government administrative management breeds what happens on the ground. Being eligible to understand public policy and policy formulation processes is insufficient for running the office – according to the teachers. In addition to knowledge and competence, there was a need for **passion**. These three were the key to developing clear guidance for project activities and innovative ways. They were enablers for the government officials to make better and more fair budget and resource allocations.

The teachers felt meaningful transformation could happen if there is a change in culture, attitudes and mentality in environmental officials at the top of government administrative management. What was concerning was that the same kind of officials were being employed at district and regional levels, and even in schools – and the consequences are always unfavourable to the beneficiaries. Moreover, there was a need to align outputs. Teachers also felt that there was a need to employ someone or a task team (outside of teachers, perhaps from the department) to monitor and evaluate the citizen science projects in schools. They felt the schools are overloaded with many activities outside of the curriculum. At the same time, the government expects "everything to start at a school level" (Teacher C, pers.comm, August 31, 2016)⁵².

Teachers were concerned that they were the ones who bear the responsibilities and consequences at the end of the day, and felt that education should be better supported and also should not be the only structure to effect change.

CMO Configuration Insight 17: *There are numerous contextual dynamics that need to be addressed in the development of learning networks and communities for CS working with schools, such as gender and water relations, lack of ubuntu ethical relations and discipline alternatives in schools, crime and insecurity as well as political will and commitment (context) that need to be considered in the planning and execution of CS programmes in schools (mechanism) to support better uptake and use of CS tools. These are necessarily contextually defined and should be assessed as such prior to programme design and navigated where possible through strategies that foreground ubuntu ethics, external support staff, realistic expectations, additional resources and other tools as alluded to above.*

⁵¹ Teacher A is from Primary school 3 in Sebokeng (refer to Appendix 7)

⁵² Teacher C is from Primary School 2 in Sebokeng (refer to Appendix 7)

g. Fostering a water management-citizen science community of practice in schools and organising annual multiple cluster workshops can strengthen the uptake and use of the citizen science tools

The teachers suggested that, outside of workshops organised by the department or municipality, they needed to have their **own internal workshops** at least once a month. A **cluster or small group of teachers** from nearby schools could meet once a month (mechanism). The group and meetings would be beneficial to remind each other about different approaches as to how citizen science information and knowledge were being taken up and used in various schools (outcome). Also, they would be able to share experiences to motivate each other as educators. They believed it would help with **consistency and rigour** (outcomes). They noted that it was easy to forget information following a single workshop, especially if no follow-up systems were put in place (context).

Lastly, teachers felt a need for the school principals to be workshopped to ensure the **principal's support** and involvement because sometimes it was difficult for them to do any projects outside of the curriculum on their own. Most teachers felt that they were

... the only ones supposed to be concerned about the changes needed, i.e. water-saving activities and lessons. The other teachers did not give us support. There is a tendency from other teachers who would not give support at all because they believe those who attended the workshop must be responsible for implementing whatever they learnt. And those who attended the workshop are expected to lead the activities. They will not get involved because they were not the ones who attended the workshop... (Teacher B, personal communication, September 2, 2016)⁵³

If there had been principal buy-in (mechanism), involving other teachers would have made their tasks much more manageable.

CMO Configuration Insight 18: *Problems of short term interventions with no follow through and lack of principal buy-in and support (context) could be addressed through school based or cluster workshops with teachers who could meet (mechanism) to strengthen their understandings and engagements with CS tools uptake and use (outcomes).*

h. Dealing with institutional and individual participants who are not capacitated and incompetent to understand the social learning linked to the uptake and use of the citizen science tools

⁵³ Teacher B is from Primary School 4 in Evaton (refer to appendix 7)

The teachers felt that the uptake and use of the citizen science tools (outcome) required some ability to understand and know how to **assess and integrate some form of social learning in a school context and institutional context** (mechanism). Most teachers felt that they were not capacitated for this task (context). They mentioned that integrating other social learning in subjects they teach was easier than that of the citizen science practice. One teacher explained:

If the workshop was about the content of social science we teach in class, we were going to effectively participate and bring our optimum best because we will be required to assess the learners based on that knowledge... So in this citizen science practice, we find it difficult to relate ourselves to its teaching knowledge and how we can help the learners to learn and relate about the importance of water. (Teacher D, personal communication, August 30, 2016)⁵⁴

Teachers also felt that the Department of Water and Sanitation and the municipality could better strengthen localised water scarcity awareness (mechanism). According to one of the teachers,

It is high time for the councillors and municipality to be radical about these water shortage issues I went to Free State, Qwaqwa, and saw how people suffer from water shortages. I even took the photos to show my kids how serious the water shortage issue is. Here people do not take water shortage seriously. They still water their gardens carelessly and wash cars with hosepipes. I became more cautious because I saw people suffering; I was not aware. I admit we are not doing enough. There are fewer advertisements on TV and radio about water issues. That could be a good platform to make people from around here more aware because they watch TV and listen to radios. (Teacher E, personal communication, September 2, 2016)⁵⁵

CMO Configuration Insight 19: *To address lack of training and skills in social learning approaches (context), there is need to integrate social learning approaches into schools that also involve commitment from DWS and other stakeholders including the media (mechanism), as this could support the social learning approaches that are required for uptake and use of CS tools in communities.*

6.7. Issue 6: Simplifying the complex governance system (SASA) in public schools and providing clear guidelines for the governance roles and responsibilities of the SGB empowering them to improve meaningful learning and teaching (e.g. citizen science education) in public schools

⁵⁴Teacher D is from Primary school 1 in Vereeniging (refer to Appendix 7)

⁵⁵ Teacher E is from Primary school 4 in Evaton (refer to Appendix 7)

One of the principals with 26 years of experience as a headmaster in different schools (he even taught some of the learners' parents) described the conditions he worked under (context):

The school is surrounded by an impoverished, **disadvantaged community**. The area was an informal settlement; hence the houses were RDP houses. According to Stats SA, 90% of the parents were **unemployed**, and most were around the age of 25 years old. We have a severe problem with **behavioural discipline**, and whenever we summoned parents to help with their children, they would not show up. The age group of most of the pupils were coming from broken families, with parents living in separate places. Grandmothers raised some learners, and it was difficult for the grandmothers to help them with homeworks. (Principal A, personal communication, August 30, 2016)

He further explained that according to the local media and the newspaper, many learners born to young parents in these areas struggled in schools because of their exposure to alcohol abuse and drugs whilst their mothers were pregnant. He mentioned that those learners were the

... type you can see that they will not pass when you start with them at the beginning of the school year not because they are stupid or anything – it is in terms of their cognitive functioning... and the district is taking a long time to make referrals... Parents are only interested in the academics of the pupils only when it involves the budget (money) or when the books need to be purchased. But if it was anything engaging them to bring ideas about improving the learners' results, they did not turn up even within the School Governing Body (SGB). They are the kind of parents that won't participate if you try inviting them to engage in water issues. A major factor that creates a lack of or weak support from the parents is that they do not have an active SGB due to their different political affiliations. There are DA, ANC and EFF ⁵⁶divisions amongst the parents.

He acknowledged that the school could be a mediator for disseminating knowledge and information about water conservation practices (mechanism). However, the school structure could sometimes be a constraint. He felt that firstly **the SGB composition and function were essential** – and they needed to be prioritised (mechanism). He described how the school SGB consisted of the CEO of the school, parents, teachers and personnel staff (i.e. people who are not educators but who were working in the school). They are all representatives of stakeholders making up the school.

⁵⁶ Democratic Alliance (DA), African National Congress (ANC), and Economic Freedom Fighters (EFF) are the leading political parties in South Africa.

It becomes easy if we discuss the issue as the SGB, and if we want to mediate water issues, then each member of the SGB must go to their respective community to deliver the message about the subject matter... I am the CEO I ensure that decisions made by the SGB are implemented in the school. However, regarding the service delivered, parents must talk to the parents, educators with educators and so on. But this is not happening; instead, they expect the principal to become a 'jack of all trades'. People are in the SGB for wrong reasons, and that is why you do not see people not wanting to work for the best interest of the school.(Principal A, personal communication, August 30, 2016)

This principal mentioned that regarding issues of water and environment, in his teaching experience of 26 years, the SGB never showed any interest in working together with ideas or solutions (context). For example, he mentioned that they had a severe problem with water shortages in the school at some point as the pressure pump was unable to pull enough water due to the number of community households connected to other parts of the pipe. After discovering the problem, he raised the issue in the SGB meeting. It was not taken seriously until he laid a complaint with the Department of Water and Sanitation who referred him to the Department of Transport. They promised to give the school money from Road Accident funds to make boreholes, but they had run out of funds before this happened. The water problem persisted until the day I interviewed him in 2016.

The principal mentioned that excursions or field trips that required taking very young learners outside of school to areas like rivers posed a challenge to them. He also noted that black African parents were raised in cultures that embodied different values and beliefs about natural water bodies compared to the liberal western cultures where many water citizen science practices take place. Water bodies and the life therein were associated with many **social and cultural beliefs and myths** (context). In his experience of being a principal in different schools, an environment where parents, educators and pupils work harmoniously was possible. Unfortunately, his current school context was different, and it **wasn't easy to make the effective collaboration** happen. He further mentioned that environmental deliberations couldn't happen. Experiences with tours for sports activities had been difficult because of a lack of communication and a lack of effective relationships between teachers and parents (mechanism). Because of **this non-existence or unproductive relationship between the teachers and the parents/community**, teachers were fearful of doing activities outside of the curriculum.

This principal also mentioned that there was **bad communication** between the school and the community. Besides the water issues, hygiene was also a problem due to disrespect of the school premises by the community who, for example, were dumping rubbish opposite the school gate. The garbage ended up dispersed all over the schoolyard on windy days. He could not imagine that kind of

school becoming an exemplary environment, in general, for teaching and learning. He felt responsibility for correcting this kind of behaviour lay with the SGB.

Besides poor communication problems, another major issue was that the teachers were not staying in the school area and therefore did not understand the extent to which water quality issues affected the community (context). They were **reliant on the information from the municipality**. However, the municipality did not engage them in anything related to water. As a result, it was difficult to understand the problem of water issues surrounding their school in general (outcomes).

I would give the water quality of this school a 45% because I was told that if you can take a glass and pour water in it, one will observe black substances. Initially, we thought because the school was new (was built in 2011) and the infrastructure was new too, we thought the particles would disappear. But so far, none of the school members experienced illnesses associated with water, but they still drink the water containing those black things. (Principal A, personal communication, August 30, 2016)

Principal A mentioned that the teachers who attend workshops could only get support if the workshop covered what was in the curriculum (mechanism). According to the school's policy, workshop feedback should be given to the entire staff within three days. Morning briefings were an opportunity for teachers to provide feedback. However, the **teachers who attended the workshop were the only ones responsible for coordinating and ensuring that their suggestions and recommendations and knowledge from the workshop were implemented. In most cases, if they did not push hard enough, the staff would not give support.**

Soon after the citizen science workshop, some learners, under the leadership of their teachers, created a drama about disturbing water issues in their communities. The play was produced for a district competition, and the school was among the top three winners. The principal was convinced of the teacher and learner commitment and success of the water project (outcome).

When asked how he was affected by water issues, he mentioned that he liked water and respected it. He said he could not go hours without drinking water, and it was a habit for him to carry a water bottle everywhere he went. This was important as he suffered from ulcers and gout. He used to be an athlete, so he understood the importance of water to one's health.

The principal mentioned in his culture that the quality of water determined a family's settlement in an area. He recalled that before occupying a new place family members would taste the water and if the water did not taste good, they would leave the area; however, if they did not have the financial means to relocate, they would be forced to remain.

In closing, he felt that the corrupt leadership of political leaders was unacceptable and had a big effect: "If the head is sick, the body will not function properly...and you leave the head unattended, then the body will suffer the consequences" . (Principal A, persona communication, August 30, 2016)

This principal had changed schools seven times in his teaching career and though the current school was the most challenging, he believed there was still hope; however **empowering the SGB** was crucial because "management of water and environment are the issues of school governance, and if some if not all of the members of SGB are illiterate, it becomes a problem".

CMO Configuration Insight 19: To address lack of wider experience and knowledge of water management in communities and schools (context), the role of the SGB is essential, and thus empowering SGBs to be more engaged in the school and community water issues (mechanism) would go a long way to strengthening uptake and use of CS tools, and would also confirm their relevance in communities (outcome).

6.8. Issue 7: The chaos: Status of Emfuleni municipality with Metsi-a-Lekoa as a water service authority

Metsi-a-Lekoa has two divisions of water issues operations: the social and technical parts (i.e. water quality monitoring and tests). The participant interviewed was responsible for the social component, including customer relations services, communication, education, call centre, and management. Their leading distributor was Rand Water and they relied on Rand Water systems. For instance, if there were water quality issues, Rand Water would be the first to be engaged, but they also had internal programmes for water quality monitoring. Rand Water had its own **blue drop criteria**,⁵⁷ which were different to the municipality's criteria (though it was not explained how these were different). In terms of the **green drop criteria**,⁵⁸ the municipality managed and monitored three wastewater treatment plants that released water back to the river systems. The unit, Metsi-a-Lekoa, was strategically located with the Vaal Dam as a supply source.

According to the unit, water supply and wastewater treatment plants were separate and had different issues. Two of the three wastewater treatment plants' infrastructure was old having been built around the 1960s and 70s. The second issue was that the human population was increasing more than the infrastructure capacity could handle. The area under management used to be small and now it is a big municipality with metro status (context).

The Vaal River is the main river, and the Rietspruit is also another stream feeding into the Vaal system. The Rietspruit flow was coming from up north – from Johannesburg, Orange Farm, before reaching Emfuleni thus pollution did not only come from Emfuleni municipality. Upstream challenges were

⁵⁷ Potable water quality compliance (cf Chapter 1)

⁵⁸ Wastewater quality compliance (cf. Chapter 1)

transferred into Emfuleni by virtue of its geographical position – being at the lower level of the catchment.

The municipality tried to reduce the informal settlements by introducing RDP houses, but there were still some pockets of informal settlements growing faster than they could handle. As far as sanitation was concerned, most of the informal settlements that were being formalised had a pit latrine system in place. In some areas, there were temporary toilets (context).

The follow-up system that Metsi-a-Lekoa used for water-saving and conservation projects in schools was as follows: they would run a workshop for the school first, then offer a tour, and then visit the schools to see the implementation progress. Monitoring was minimal because of a lack of resources and lack of human personnel capabilities and capacity (mechanism).

They had a system whereby customer relations worked with schools to monitor progress; however, they were limited in enforcing the implementation of their projects in schools. They could not hold the schools accountable for implementation; they felt the Education Department should ensure implementation. They claimed to have good relations with Education Department, which included two districts (west and south). They gave the municipality access and allowed them to deal directly with the schools, in particular primary schools. Programmes in high schools only entailed creating awareness.

The reason why the municipality mainly dealt with primary schools was that: "we feel it is where we need to start because the pupils' age permits the ability to grasp information and transmit it to their parents. It is easier there" (Metsi-a-Lekoa official, personal communication, September 12, 2016).

The municipality felt that it was necessary to have **personnel who could monitor the progress in schools on a full-time basis** because, at the time of the interview (i.e. 2016), they had only one person who dealt with school water projects. The workload was too much for one person. It was difficult for one person to make follow-ups due to the large number of schools in the municipality. It was also not always possible to visit the same school twice a year; as a result, the projects regressed (context).

The Metsi-a-Lekoa official mentioned that it was the municipality's responsibility to ensure that some of the challenges were resolved rather than holding schools responsible for all the challenges (outcome).

The areas the Metsi-a-Lekoa managed was almost 83% urban and 13% was rural. Their main focus was the urban area where they supply potable water. Tap water was supplied to the community so they should not have needed to fetch water from the rivers even in the informal settlement.

Metsi-a-Lekoa noticed the gradual pollution of streams; however, the significant pollution only occurred when the **sewage infrastructure was failing**. Sewage flows from upstream outside of Emfuleni jurisdiction, such as sewage leakages in the Rietspruit and Klipspruit coming from Mid-Vaal municipality, were also challenging. Although Emfuleni was at the mouth of the Vaal River system, both Metsi-a-Lekoa and Emfuleni municipality were not responsible for managing the 'green drop' compliance of the Vaal River system. DWS and Rand Water were responsible for this, with Metsi-a-Lekoa only accountable for river quality education and awareness. They had programmes with NGOs around Evaton and Sebokeng. Those programmes responded differently to different needs of the communities regarding pollution, littering and manhole blockages. For example, they worked with Phaphamang NGO, which established programmes involving schools in awareness, monitoring and cleaning of the streams. Ultimately though, DWS was responsible for resolving these challenges (context).

Metsi-a-Lekoa realised that running these programmes helped them better understand the communities and their water challenges (outcome). The official mentioned that Mid-Vaal also experienced similar problems due to industrial activities that contaminate streams. The Kliprivier waters that connect Emfuleni and Mid-Vaal were quickly affected if Mid-Vaal did not monitor their streams. During the interviews in 2016, water restrictions were gazetted due to the decline of the water (32%) level of the Vaal Dam. Metsi-a-Lekoa were still able to distribute potable water for domestic use and to small businesses. However, some areas were affected more than others. Big companies like ISCOR received water directly from Rand Water.

Another problem within the management of the Emfuleni municipality was that environment and water issues were separated and handled by different departments. The role of the environmental section was to deal with all kinds of pollution, including that of water. However, the environmental management unit did not have the capacity.

DEA and DWS appointed Rand Water as the only water services authority; as a result, they became the only competitor. Being the only competitor was a challenge because there was no quality benchmark, and they were the only ones setting up the pace of progress.

The Metsi-a-Lekoa official explained that the sewage infrastructure was failing because the pipes had been installed a long time ago (as far back as the 1950s). The human population had increased and the infrastructure did not have the capacity and pipes were constantly bursting or blocking. This ultimately affected businesses and the economy (context).

Another service provided by Metsi-a-Lekoa was the **customer services call centre**. The call centre's role was to build trust in the community by workshopping the community about water-related matters, responding promptly to complaints, doing site visits, writing reports, etc. (mechanism).

CMO Configuration Insight 20: *To address the complex variety of water management challenges in the local municipality (context), and thus to also identify what role CS tools could play in this wider context of challenge, involving in municipal officials and other stakeholders in the workshops could help to identify what specific role the CS tools uptake and use in schools can play (mechanism), and then also identify how this can be complemented by other actions and approaches in the local municipal context to strengthen overall approaches to CBWQM (outcome).*

6.9. Issue 8: Teachers' recommendations on improving and sustaining uptake and use of the citizen science tools in their schools

Related to the above CMO Configuration insights, teachers from this study's schools recommended the following:

- There is a need for primary schools to take responsibility together with their management team.
- Reinforcement of the context and content of understanding water issues in the curriculum is pivotal.
- The Department of Environmental Affairs should take the lead in taking citizen science practice forward in primary schools.
- Citizen science practice requires all staff members to participate for it to be meaningful and sustainable in schools.
- Citizen science practice in schools should be an integrated process, not a once-off project/event.
- Teachers needed the school or the curriculum to create time and opportunities for them to practice citizen science.
- There is a need to challenge traditional gender roles and responsibilities in schools.
- Engaging in water issues should not be taken as obligation and should be personalised.
- Ubuntu practice and knowledge should be integrated into this kind of citizen science practice.
- The need for deploying and employing relevant people with experience in the environmental field is crucial, from the level of the department ministers to the teachers on the ground.
- Municipality and councillors should take responsibility for creating efficient awareness about water issues

These all resonate with the CMO configuration insights identified above (CMO Configuration Insights 1-20) which triangulates these insights and helps to confirm valid ways forward and points to the validity of the CMO configuration analysis presented in this chapter, building on the deeper contextual insights offered in Chapter 5.

6.10. Summary of Chapter 6

This chapter analysed the CMO configurations of the primary schools in this research project, who overall exhibited less fluidity of 'democratic' participation because of their nature of increased isolated and rigid 'structural, cultural and political' regulations with different values which affected citizen science practice and the uptake and use (sustained uptake and use particularly) of the CS tools in the schooling setting.

The chapter emphasised the strong influential role the citizen science intervention played in creating the following spaces:

- for science-social knowledge co-creation and sharing,
- empowering social and classroom learning,
- and promoting social responsibility for developing quality education through public primary schools.

However, it requires '*sitting down and talking*' during the planning process, both hierarchical and longitudinal planning, so that the plans can be translated effectively at different levels in a sustainable, usable and beneficial manner. The '*sitting down and talking*' (both literally and metaphorically) involves ubuntu ethics (in the form of 'reconciliation talk' as per Cameron, 2007) including respect and careful deliberation of issues and interventions with the following intentions: (a) to firstly involve all the stakeholders to maximise understanding and empathy, (b) to negotiate better and fair decisions and (shared) values linked to the intervention to accommodate everyone involved in the chain of service delivery, (c) to allow stakeholders to undertake accountability on their own, (d) and to ensure that every activity involved was intentional with a purpose. The ultimate goal is to improve the intervention and maximise its impact and benefits. If all the efforts of '*sitting down and talking*' are overlooked, then all that is beneficial for learning development, ultimately, the development of quality state education, might end in vain.

This chapter demonstrated that citizen science practice and intervention were limited to their tools and offered user-friendly and innovative techniques that can also benefit water use and water quality management. There were many challenges, such as lack of accountability and the lack of intervention evaluation and sustainability processes. It was also apparent that citizen science practice, if

strengthened and supported in public schools, has the potential to transform teaching and learning processes to achieve the quality education the state aspires to, both in the classroom and extending to the surrounding community in large. The 20 CMO Configuration insights offered across the chapter provide ways of considering how this can be done at different levels of individual teachers, schools, professional learning clusters, and the school in its community, including the role of the DWS and wider governance structures. The chapter also shows that identifying issues is a helpful way of identifying CMO configuration insights. As shown, every outcome depends on its subjects and circumstances (Pawson & Tilley, 1997). The chapter offers insight into the complex relationality that exists between context, mechanism and outcome in this case. The next chapter deals with the next case and its context.

CHAPTER 7

MPOPHOMENI ENVIRO-CHAMPS CONTEXT

7.1. Introduction

The context of Mpophomeni enviro-champs has been introduced briefly in previous chapters as part of the bigger picture of the entire project (see Chapter 1). Here I present it in more depth and detail to demonstrate its complexities and how the intervention unfolded here. Though the project implementation strategy was generalised across both cases, the public primary school teachers and the Mpophomeni enviro-champs, the mechanisms and outcomes turned out to be different. Furthermore, the enviro-champs were constituted by a different demographic of members with varying purposes for participation. Therefore, the reality and mechanisms for the participants in the projects' internal and external structures and cultures were unpacked and challenged. Unlike in the teachers' case, where the setting was confined in a public school where classroom learning was encouraged, in the case of the Mpophomeni enviro-champs, the setting was more fluid (i.e., the mechanisms could come from anywhere, and outcomes could be produced from anywhere and everywhere). Social learning was promoted in this setting due to its embeddedness in society or community. This chapter presents answers to the following questions as background for evaluation: (a) Who, why and what citizen science tools were introduced? (b) Who were the Mpophomeni enviro-champs, and what community were they from? And, (c) the study demonstrated an interest for evaluation in this context and the need for sustainable water quality management through citizen science (see section 1.6).

7.2. Introduction of citizen science tools and programme to the Mpophomeni community

The citizen science tools were introduced as an integral part of an already existing programme that was operational for a different purpose as briefly noted in Chapter 1. Thus the introduction of the citizen science tools was intended to strengthen the programme through an anchor of scientific evidence, as elaborated further below.

The Mpophomeni (via the uMthunzima stream) community water issues have been studied extensively, especially regarding water quality issues by many NGOs e.g. Midlands Conservancies Forum, Mpophomeni Conservation Group, DUCT, GroundTruth, WESSA, etc. The citizen science observations of the initial 10 enviro-champs were later expanded to a group of twenty. These enviro-champs were selected in 2011 through the uMngeni Local Municipality (located in the uMgungundlovu District Municipality) as a part of the uMngeni Ecological Infrastructure Project (UEIP) Save Midmar Dam in support of Mpophomeni Sanitation Education Project (MSEP), which was a DUCT

(and WESSA) water project. The **purpose** of establishing these enviro-champs was **to create resilience and a 'joint' citizen participation mechanism that would empower the communities and improve service delivery** (Taylor & Taylor, 2016).

The MSEP, through the enviro-champs, has undertaken various water quality awareness projects within the Mpophomeni community. One of them involved reporting sewage manhole spillages for about four years; the sewage spillages continue however. Figure 7.1 below shows a typical example of the problem experienced and monitored by the enviro-champs.



Figure 7.1 Untreated wastewater overflowing from a manhole into the uMthinzima Stream, Mpophomeni
(Source: Ward, 2016)

Two significant episodes happened that raised my interest in evaluation on this site. Firstly, even though the citizen monitoring started in 2011, it was only in 2015 that a meaningful change that involved an active response by the municipality to address the leaking manholes took place (A. Lepheana, personal communication, February 12, 2016). The question arose as to **why it took so long to obtain responses to citizen monitoring practices. What was in the citizen science tools that ultimately enabled this?**

The second issue involved the demographic profile and working conditions of the enviro-champs. The community members who participated in the enviro-champs programme ranged from young primary school learners to older people up to 64 years of age. Those who were full-time volunteering in the programme were primarily young adults born between the 1980s and 1990s, and four volunteers were born in the 1970s. Gender was reasonably balanced, almost 50/50 males and females. The formal education level achieved varied from Grade 9 to 12. Some members received government social grants, and the average number in households these members belonged to was six. The number of dependants in the household ranged from 1 to 7, and the average number of children attending school from the same household was three. This demographic profile indicated that the members of the

enviro-champs had varied family responsibilities and aspirations, and the benefits of participation varied.

Since 2011 enviro-champs have been taking up and using citizen science tools to monitor the Mpophoneni streams voluntarily. Gradually a stipend in the form of airtime or monetary allowance was introduced to compensate their efforts. The **second significant episode** happened between December 2014 and January 2015 when there was no stipend for these enviro-champions. Consequently, some of the members withdrew from the programme and went to look for employment (T. Luvuno & A. Lepheana, personal communication, February 12, 2016). This incident raised the question of **how citizen science practices were supported**. It also introduced **issues around assumptions of the volunteerism approach embedded in citizen science practice of this nature**.

For the proposed evaluation study, the latter issue raised the need to probe the sustainability and agility to meet the participants' needs of the citizen sciences practices and to explore the conditions in which citizen sciences practices thrive (or not).

7.3. What were the citizen science tools introduced? Uptake and use of the citizen science tools by the enviro-champs

Unlike in the public primary schools' context, whereby the main tool introduced was the miniSASS toolkit, a few additional citizen science tools were presented here combined with some creative approaches or activities to support the tools.

Some of the activities below [from (i) to (iii)] activities were already in use before the citizen science activities [i.e. from (iv) to (ix)] were introduced.

- i. Door-to-door visits and geo-map plotting; door-to-door environmental awareness
- ii. Sewer or manhole monitoring
- iii. Freshwater leaks – fixing taps and pipes leakages
- iv. Testing water – uptake and use of citizen science tools
- v. Children's outings or excursions
- vi. Drama rehearsals
- vii. Kids club
- viii. Consolidation of data and report writing
- ix. Enviro-champs training and reflection days

The tools required different levels of scientific understanding that decision-makers need to consider. Not all the tools were easy to apply. The following are the tools introduced and the conditions under which they were meant to be used.

- miniSASS

MiniSASS - Mini-South African Stream Scoring System (miniSASS) is a 'bio-monitoring' tool that has been developed into various forms. (refer to www.minisass.org)



Figure 7.2: MiniSASS tools. Top left: Cell phone app used to calculate the readings and a magnifying glass for identifying species. Bottom left: Map of streams that citizens have tested

The first citizen science tool introduced to the enviro-champs was a booklet, the miniSASS manual. Over time with GroundTruth miniSASS developments, the enviro-champs were introduced to the miniSASS mobile application (see Figure 7.2), allowing data to be mapped onto Google Earth maps. Following this was the water clarity tube and transparency velocity head-rod. The reasons why these tools were introduced in this sequence was not evident in the document and practice except that the miniSASS booklet was easy to read, interactive and fun (T. Luvuno & A. Lepheana, personal communication, February 12, 2016; Taylor & Taylor, 2016), so it laid the foundation to apply the tools. Furthermore, the **gradual introduction** of other tools meant users could gain confidence in using the miniSASS manual. The tools introduced afterwards required another **level of scientific and intellectual aptitude** (reported by the team in the International Citizen Science workshop, February 2016).

MiniSASS stands for a simplified (i.e. reduced taxonomic complexity) Stream Assessment Scoring System (SASS). It was launched in 2000 by the Water Research Commission (WRC). It is a scientific bio-monitoring tool (in the form of a leaflet) that uses the sensitivity of different (19) classes of invertebrates to indicate a stream or water resource quality/ water pollution level. It is one of the

oldest citizen science tools used in South Africa, specifically in KwaZulu-Natal province, for monitoring water quality and had extensively researched scientifically (Cele, 2015). It was developed to be user-friendly for the community or non-scientists since the SASS that was used by the Department of Water and Sanitation (DWS) was too complicated and required high levels of scientific expertise for the ordinary citizen.

Supporting learning materials for the miniSASS: Field guides support the miniSASS, and sampling kits such as nets, trays, magnifying glass, bottles, forceps, etc., help citizen scientists to collect and identify the invertebrates. These sampling kits can be self-made from recycling household materials if one cannot afford actual tools. Household materials required to make the miniSASS tools may need to be carefully chosen or adapted, for instance, the porous material used for the net has to have holes that are not too big to catch minuscule invertebrates.

The use of miniSASS required **training** to be able to interpret scores and assess data produced by the miniSASS. In the beginning, training was offered through WESSA's Eco-Schools programme. The community members acquired training via NGOs or were self-trained via the internet and social media platforms.

What to do with data: After collecting the miniSASS results, the results are documented and uploaded on the miniSASS geospatial website (www.minisass.org) or the Google Earth miniSASS database that GroundTruth developed. Cele (2015) found that uploading also needed specific technological skills so that citizen scientists do not need to rely on one skilled person. The website was an open-source platform that allowed the public to gather and share data accessible on mobile devices. To reach a wider audience and network, the information that sometimes includes uploading photos on the internet, can be accessed and shared via social media platforms that also require internet and data units. Images usually needed a smartphone for clear visibility.

In the last part of the process, results are consolidated and a report is written on the overall observations collected, either on the same day or over some time.

Sampling method for conducting miniSASS: MiniSASS results can help identify where the pollution or contaminants are coming from in the stream but do not necessarily identify the types of pollutants. To find out the nature of the pollutants, chemical analysis is required in the laboratory. Again, to find out where the contaminants are coming from, one needs skill and understanding of the stream to be able to choose sampling points strategically. However, for the results to be reliable and trustworthy, sampling must take place in a particular way:

- Firstly, Cele (2015), quoting Graham et al. (2004), mentioned that the sampling points should have vegetation growing on the sides, be shallow, with fast-flowing water, and there needs to be an availability of stones.
- The citizen scientists must step into the stream to do sampling.
- The citizen scientists must wear protective clothing.
- There is a specific way to draw water.
- The citizen scientists need to know the history and the status of the stream including being aware of the activities happening around and about the flow.
- There is a need to understand the reasons for the citizens to monitor the stream.
- The citizen scientists must at least have an idea of the kind of invertebrates occurring in the 'clean' stream.

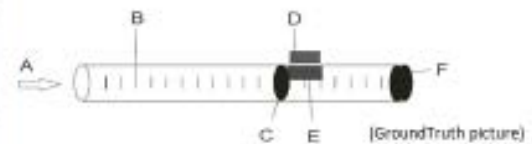
Benefits of using miniSASS: Cele (2015) mentioned the following, although they do depend on the context:

- Educational value,
- Social learning - however, the two qualities were not transparent when one acquires them during a workshop or training or practicals.
- Community empowerment
- Stream custodianship
- Stream clean-up days
- Raising awareness about pollution
- Identifying root causes of pollution
- Governance of water resources
- The use of technology in monitoring stream health
- The development of partnerships for stream health: between organisations, organisations and government, individuals and organisations or government, individuals and individuals within or between structures.

- **Water clarity tube**



Figure 7.3: Water clarity tube demonstration



- A: Clear base for viewing disc (C)
- B: Metered scale in cm on the side of the tube
- C: Black disc; moves inside the tube to indicate clarity
- D + E: Magnet for moving the disk (C)
- F: Black stopper-cap for sealing the tube

- Tool used to measure the clarity of water.
- Clarity gives information about water quality.



Figure 7.4: Water clarity tube and how it is used. The left image shows how the clarity tube should be held when doing readings. The bottom photo shows the users' posture when scooping the water to avoid bubbles.

What is it? The water clarity tube is a citizen science tool designed to monitor water clarity. It is an indicator of turbidity and total suspended solids (GroundTruth, WRC & WESSA, 2016). Water clarity decreases with an increase in turbidity or suspended solids.

How to use it? Instructions are provided in a booklet developed by GroundTruth, WRC and WESSA (2016, p. 3) a outlined below:

- One decides on a location to collect the sample. Make a note of the site, either with a GPS or a map. Name your site to find the site again in the future.
- Place the clarity tube in the water with the open end facing upstream to collect a sample. Dip the opening beneath the surface and allow the tube to fill with water. NOTE: Make sure there are no bubbles in the tube (bubbles will affect the reading).
- If there is no way to collect the sample using the above method, use a clean bucket to collect the water and pour it into the tube.
- Once the clarity tube is full, with no bubbles, seal the clarity tube with the black stopper cap and make sure it is secured.
- IMPORTANT NOTE: Don't stir up sediment when collecting your sample. It will affect your readings!
- The tube is now full of water, and you can start to take your water clarity measurement.
- Hold the tube horizontally, with the clear base facing toward you. If there are any bubbles in the tube; tilt the tube slightly so that they gather at the stopper-cap end. This will prevent bubbles from interfering with the reading. Stand with your shoulder perpendicular to the sun so that when you lift the clarity tube up to your eye, the sun is shining into the tube at 90 degrees.
- Use the magnets to move the black disk inside the clarity tube to the 1cm marker. Look through the clear base of the clarity tube and slowly move the black disk (using the magnet) away from you. When the black disk has completely disappeared from your vision, make a note of the relative cm reading at that point.
- Now, push the disk all the way to the stopper cap. Then looking through the clear base, slowly move the disk toward you. When the black disk becomes visible again, take another relative cm reading.
- To calculate the water clarity, calculate the average of the two readings you obtained. Make a note of your reading.
- IMPORTANT NOTE: Readings do not change significantly if you are standing in shade or sun. However, do not take readings in dappled light as this will affect the result.

- You need to take readings in full sun or full shade.

The enviro-champs members mentioned that they had experienced difficulties when using the water clarity tube because it required them to go into the stream to collect the sample. This was problematic at the beginning of the project as the sewage effluent was very bad, posing severe health risks.

▪ The transparent velocity head-rod



Figure 7.5: Transparent velocity head-rod. Left: Held by Ayanda Lepheana during the demonstrations. Right: A closer look at the transparent velocity head-rod (WRC, WESSA, and GroundTruth)

What is it? The transparent velocity head-rod is a citizen science tool that is 1.1m high and designed to measure the stream velocity and discharge. It is made up of transparent, lightweight plastic (unlike the original one that was made of hardwood) so that it can be carried around with ease.

How to use it? The velocity of a stream can be measured by holding the velocity head-rod so it touches the bottom of the stream and is perpendicular to the streamflow. Because it is only 1.1 m high, the stream depth must be between 5-90cm deep. The stream has to have a distance of between 5 and 30 metres (depending on how fast the instream water is moving). Sampling points should be at any point of the stream where the stream bed is uniform and there are no large boulders; and must be in the stream where water is less turbulent and the flow does not change rapidly. (GroundTruth, WRC & WESSA, 2016, p. 2).

To calculate the velocity, the citizen scientist must place the head closer to the water surface and 10-20cm away from the tool in order to be able to read the measurement as accurately as possible. In order to read the measurements, the citizen scientist must simultaneously read the elevated level of oncoming/flowing water from one side of the tool and the level of depressed water on the other side of the tool. This needs to happen before getting the velocity as described by GroundTruth, WRC and WESSA (2016, p. 3) :

- The difference in height between the maximum point and the minimum point is called ΔH (delta H, or change in height) and is measured in cm.
- Write down the ΔH . Find the ΔH on the table of velocities and determine the corresponding velocity for that ΔH .
- At each measurement point in the stream, take two or three velocity measurements. Determine an average of those velocities to give the final velocity for the measuring point chosen. But wait for about 20 seconds before reading the measurements and take the readings at least twice.

To use stream flow velocity to measure discharge: In brief, to measure discharge, “you need to measure your stream velocity and multiply it by the area of your cross-section. To get the area, the depth of the channel must be known. Measuring the depth is an additional step in the transparent velocity head-rod measurements process. Use a measuring tape to determine the width of the stream. Use the discharge formula to determine the discharge. In short, **discharge = area x velocity**. However, the calculations are more complex than that” (GroundTruth, WRC and WESSA, p. 4). Thus, considerable intellectual ability is needed to calibrate the reading on the velocity head-rod and to work out different calculations.

The above procedures and calculations related to uptake and use of the citizen sciences tools raise further interest for the proposed study. My aim was to understand why and how the citizen science tools were taken up and used by the enviro-champs. And how (if at all) this helped them participate and engage (if so, to what end) in water resource management practices.

Above is a background of the type of citizen science tools introduced and the varying levels of scientific comprehension required for using them. The following is a background of the enviro-champs and the community and place they belonged to. The intention is to demonstrate the sorts of dynamics to consider when developing interventions like citizen science projects of this nature.

7.4. Context of Mpophomeni community

7.4.1. The water quality issues in the Mpophomeni community and the citizen science tools engagement

This section describes the social context before the intervention.



Figure 7.6: Mpophomeni township location in relation to Midmar Dam

As shown in Figure 7.6, Mpophomeni Township is located about 3km from Midmar Dam, near Howick in KwaZulu-Natal. It has a minimum elevation above sea level of 1046m, an average of 1063m, and a maximum of 1100m (Google Earth). The data about the location of Mpophomeni township in relation to the dam and the stream characteristics is important for understanding water quality from both natural science and social science perspectives. Specifically, the focus was to evaluate the uptake and use of the citizen science tools to manage water resources, including the streams. In terms of elevation data, the Mthunzima stream in Mpophomeni (case study site 1) was **shallower** than the Vaal rivers flowing past the Vaal-Triangle primary schools (case study site 2) to the Vaal Dam. The depth of the stream mattered: the Vaal-Triangle teachers found it more challenging to do practicals at the Vaal River compared to the Mpophomeni enviro-champs. The distance between Mpophomeni to Midmar was shorter than between the Vaal-Triangle primary schools and the Vaal Dam. As a result, the logistics of planning to visit the rivers were different, and their proximity affected their relationships.

7.4.2. Water-related issues in Mpophomeni Township before the intervention

Midmar Dam not only supplies half the province of KZN with potable water, but also provides recreation amenities (swimming, sailing and canoeing) and is home to various competitions, some of which are internationally recognised, such as the Midmar Mile – an annual swimming event. Near the dam, up the Nkuka and uMthunzima streams feeding into Midmar dam, lies the Mpophomeni community inhabiting a township of mostly RDP houses or low-cost housing. The Nkuka and uMthunzima streams have been affected by – and were also contributing to – the degraded water quality and quantity due to dysfunctional sewage systems, which increased nitrate and phosphorus loading. Illegal dumping (Jonsson & Klasander, 2014) has also affected water quality and led to wetland loss. These forms of pollution end up in Midmar Dam, thereby compromising the availability of potable water. Also compromised is the distribution of water to communities, in particular, Howick, that uses water from the dam. Midmar Dam not only provides potable water to the local Mpophomeni community but water is also distributed as far as the significant economic cities of the province, Durban and Pietermaritzburg, making the management and care of the dam even more of a priority beyond the Mpophomeni and Howick boundaries (Denver, 2012).

Van Deventer (2012) looked into the root causes of water pollution contributing to Midmar Dam. The IDP and the Umngeni municipality development plan documents that guide the region's developments and actions reported inadequate sewage infrastructure that did not meet the needs of the growing population of Mpophomeni Township. As for illegal dumping, Ayanda Lepheana (personal communication, February 12, 2016) explained that it was because of inadequate and inefficient administration of the waste collection and management services by the municipality/government. These are fundamental reasons though they do not give a holistic picture of why water pollution was a problem. A holistic view needs to include cognitive, social, cultural, religious, etc., understandings and settings that can give better empirical evidence of the water pollution situation and why it continues in Mpophomeni. The literature about the pollution here appeared to provide only one side of the story. It was concerning that one could not see or hear narratives on how, in reality, the community from Mpophomeni also related **positively** to the streams and the dam. And how pollution has affected these relationships. Thus, to understand the water pollution situation in Mpophomeni, one needs to understand the holistic context, which includes the significant historical developments contributing to the water status in 2016.

Programme evaluation is a systematic process whereby different stakeholders and decision-makers assess if their purposes were met and how and trace what changes occurred to see its performances and outcomes (Hogan, 2007) – going through historical developments is therefore part of the process of understanding the enviro-champ context. The difficulty was finding relevant ecological history and

how this related to the people of Mphopomeni, especially in the literature; hence, this context relied on interviews. In the historical development of an intervention, one can trace mechanisms and outcomes involved in continuing to create new or refining contexts in the evolution of the project. In this case, I refer to the capacity to engage the relationship between social and ecological facts and values, to accommodate the range of understanding and concerns of those involved and affected (Porter, 2015a). Consideration of such background intends to support decision-makers to make a fair judgment informed by what is explained and presented by those in the project rather than what is found in this study.

7.4.3. Who was the Mpophomeni community through the lens of the enviro-champs? The pre-existing cultural powers that enabled or disabled the intended mechanisms of change

Mpophomeni Township was established around 1969 as a dormitory residence forming Howick's 'Black belts' (Denis, 2013). These are the black communities who migrated from the rural areas to work for the South African Rubber Manufacturing Company Limited (SARMCOL) and in the construction of Midmar Dam. Many had built homes where the dam currently is. Unfortunately, they were forcibly removed when the dam was built and from Howick West to occupy the space where Mpophomeni is at present. According to Denis (2013), since the Group Areas Act forcibly removed them, the Mpophomeni community developed an **'antagonistic' relationship with the homeland authorities**.

Politically, the township started to be noticed during the bus boycott around 1982 when the Mpophomeni community refused to accept the bus fare increment and demonstrated solidarity and activism for the cause (Denis, 2013). The protest was exacerbated when the BTR SARMCOL did not recognise the Metal and Allied Workers Union (MAWU) to which many workers belonged. In 1985, about 900 workers (majority UDF⁵⁹/ANC) were dismissed and replaced by Inkatha.⁶⁰ This protest was regarded as one of the most prolonged ruthless attacks and violent politically infused labour protests – ANC against Inkatha – that happened in South African political history, from around 1985 to 1993 (ibid.). Many lost homes and lives. It took almost 13 years for the dismissed workers to be compensated for unfair dismissal. These events attested to and demonstrated how politics played a significant role at Mpophomeni (cf. Chapter 8).

⁵⁹ UDF is the United Democratic Front which was established around the 1970s and launched in 1983 as a united non-racial anti-apartheid body of more than 600 organisations that aimed at fighting oppression and were in support of the Freedom Charter. Amongst the affiliated organisations were over 300 youth organisations, more than 80 civic associations and nearly 50 student organisations. (<https://www.sahistory.org.za/article/united-democratic-front-udf>)

⁶⁰ Inkatha Freedom Party was established in 1975 under the leadership of Prince Mangosuthu Buthelezi. Its main support was the Zulu people. The violent rivalry between the ANC and Inkatha political camps had a huge impact on the youth psychology of that time (Maré, 1991).

Mpophomeni came into the spotlight again even internationally during the dismissed workers 'protracted court case' (ibid.). This study was not only interested in the 'act of endured solidarity' by the Mpophomeni community, but also in unpacking the overwhelming involvement in research by the community of Mpophomeni as discussed in Chapter 4. 'Research baggage' was accumulated from the national and international research conducted by the labour experts, anti-apartheid activists, academics, church activists, environmental activists, health care activists, Truth and Reconciliation Commission, etc. in the name of **community development, raising awareness and advocacy** of some sort (Denis, 2013). As Thandanani Luvuno (personal communication, February 12, 2016) voiced,

You researchers come and go, extract our knowledge and information, for your benefits like your PhDs and articles ... so tell me what do we benefit [from this research] as the community of Mpophomeni?

The above quote played an essential role in questioning the ethics (ubuntu) of research in vulnerable places like Mpophomeni. It was also crucial for realist evaluation of this nature to evaluate the consequences of the programme outcomes specifically for those who were affected (see Chapter 4).

Another important feature was the establishment of some parts of Mpophomeni, specifically the RDP houses, through Khayelitsha Housing Project by the uMngeni municipality. These houses were built very close to Midmar Dam, causing a conflict of interests between the municipality and the environmentalists from the Department of Water Affairs and Forestry (Douman, 2008). Around 2008, the municipality was 'caught between a rock and a hard place'. The municipality had to choose between building 4 000 low-cost houses to accommodate 20 000 people who did not have homes at that time, and dealing with the consequences of building houses that threatened ecological goods and services. The list of concerns mentioned by the environmentalists included maintaining the integrity of wetlands, maintaining the quality of drinking water from the dam for residents downstream from Howick to Durban – as well as the loss of recreational amenities and sporting events like the annual Midmar Mile event (Douman, 2008). The environmentalists were also concerned about the malfunctioning of the sewage system infrastructure at that time. The worry was that should the new houses be built by the municipality with insufficient attention to infrastructure, the sewage would spill into the streams and ultimately the dam. This was of concern in 2016 when this study commenced, and continued to be a problem, as indicated by the WRC report on the CBWQM scaling project (Lotz-Sisitka et al., 2022).

The political history of South Africa, however, had positioned the municipality in a difficult daunting dilemma in terms of decision-making, primarily because these kinds of decision-making processes are

deeply rooted in **values**. Values about who should, and what should be benefitting now, and in the long-term? How? For what purpose and under what circumstances? And what were the implications? These questions were similar to those on which this study was based and were important to consider in terms of how decision-makers like WRC, DWS, etc., will deal with situations should citizen science projects of this kind be upscaled and require support.

Working with data and literature back and forth, this study selected essential and relevant events and perceptions/reasons that affected the environment in which the enviro-champs and the citizen science intervention was embedded. The following section considers the reality of the socio-political rules, norms, values and interrelationships, which can make the intervention mechanisms efficient and sustainable. These include opportunities and sustainable ways of participating through the uptake and use of citizen science tools, for the enviro-champs of Mpophomeni, in the decision-making arena.

7.4.4. What is real to the enviro-champs in terms of public or civic participation in the decision-making of water quality management via the uptake and use of the citizen science tools? The pre-existing powers that enable or disable the intended mechanisms of change

Public participation through citizen science practice as considered in this study has a better chance of being taken seriously at a local municipality level because of the following characteristics/values: **putting the people and their environment at the centre**; its proactiveness; its ability to make the participants accountable/ develop their own agency; its **openness and transparency** and its potential for enriching ethics in interventions. These values are at the core of the Batho Pele principles. Batho Pele is a Sesotho/Setswana expression meaning 'people first'. They serve as a broader cultural strategic mechanism designed to govern the legislative frameworks for public service delivery aligned with the constitutional values. This includes enhancing civic participation and accountability in policymaking and creating an accountable public administration (Department of Public Service and Administration, 1997; Mofolo & Smith, 2009). Using these principles can improve public service delivery as intended by citizen science practice, including that of water quality management at the local (administrative) municipal level (ibid.), to which the enviro-champs have direct access. The enviro-champs benefit from strengthening the culture of these principles at the municipal level, and the local municipality benefits from demonstrating good and harmonious cooperation in working together with citizens to manage water quality.

Before the enviro-champs can make environmental (water quality) governance visible through public participation in the local municipality, they must follow official political channels (T. Luvuno, personal communication, February 12, 2016). The official political channel included but was not limited to being 'politically' active and involved in the ward committees because this was where many local plans and decisions were made. Here many governance and developmental queries are raised (ibid.). For

instance, the municipality's Integrated Development Plan (IDP) was drafted at this level. Enviro-champs should be politically informed about their surroundings because this is both their human right and responsibility. Integrating themselves with what already existed can also provide a good kick-start. Every right comes with a responsibility. Amongst the responsibilities mentioned in the South African Bill of Responsibilities were (i) the responsibility to ensure the right to live in a safe environment and (ii) the responsibility to ensure the right to citizenship which includes contributing to the issues of the country to make it a developmental state.

7.5. Summary of Chapter 7

This chapter focussed on the following contextual aspects: the intentions of the CS interventions, the background against which it was planned, and how it was integrated. The chapter looked at what citizen science activities and tools were used and taken up, how and why. As the context was revealed, more and more of the layers of realities were discovered, starting from where the water quality issues emanated and how the water issues affected different aspects of the history, psychology and daily livelihoods of the community and the enviro-champs. Hence, in the next chapter, the study examines more deeply the conditions required for the sustainability and agility of the intervention through issues that reveal CMO configuration insights.

The chapter also explored the politics and community context of the Mpophomeni enviro-champs. It discovered sensitive and complex issues involved, including their vulnerability as a community in the context of socio-economic status and exposure to research involvement. At the same time, the chapter also showed the community's resilience and where their reasonings were rooted. It exposes where realistic opportunities or resources can be explored to make the intervention more meaningful in changing their livelihoods, a focus that will be carried forward in the next chapters.

CHAPTER 8

MPOPHOMENI ENVIRO-CHAMP FINDINGS : ISSUES REVEALING CMO CONFIGURATIONS

8.1. Introduction

The findings of this chapter are presented differently from the findings of the primary school teachers because of the unique and sensitive nature of the citizen science intervention for the Mpophomeni enviro-champs. By unique and sensitive nature, I meant as a data custodian and steward, I needed to handle the enviro-champ responses with care and pay careful attention to the execution of the intervention. Unlike in the context of the primary school teachers, whereby the intervention can be considered an accessory or an added value to their profession and practice, in the case of the Mpophomeni enviro-champs, it carried a deep belief of virtue. Also, unlike in the teachers' case, the intervention was still operational in 2016 and continues into the present. Hence, the findings were presented in the following manner:

- Their intervention had two life cycles or two phases. Each phase had its issues within its context. Therefore, it was essential to evaluate the CMO configurations per phase, i.e. the first phase was from November 2011 to October 2015, and the second phase was from November 2015 to September 2018.
- Every issue had underlying issues that needed unpacking in demonstrating their context, mechanism and outcomes, i.e. creating nested layers. Hence, I tabulated the main issues with their sub-issues. The contexts of sub-issues give the context of the main issue. Without showing their context, the meaning gets lost or becomes conflated.
- I demonstrated how the enviro-champs as individuals, collective, and community of Mpophomeni were affected by the water issues and the intervention, and showed the implications of each.
- The meaning of the intervention was deeper, personal and affecting issues closer to home for the enviro-champs. There was considerable hope invested due to how water quality issues and the intervention are intertwined in their daily livelihood.
- The fundamental reason for presenting findings in a table was to ensure that each issue was accompanied by its context and showcases its mechanism(s) and outcome (s). The table provides a means for a systemic evaluation of tracking carefully what works for whom, under what circumstances and why. I tried many methodological processes where I would separate findings and describe them according to the structure of the other findings chapters. But the

findings here did not have a meaning without demonstrating empirical evidence; as a result, this format could not capture the essence. This is why a table format was chosen.

- The issues were characterised based on the participants' positions and roles in the enviro-champ project and the Mpophomeni community. This was to demonstrate how different participations were affected by the intervention.

The evaluations of the mechanisms do not only go as far as reasons and resources, as Pawson and Tilley (1997) explained. It also is important to consider how many times something occurred (i.e. the frequency), the psychological, affection, physiological, sociological, economic, and organisational processes involved. These features were the main contributions to the in-depth understanding of mechanisms in the CMO configuration theory, and they are the main reasons this chapter had to be written in this manner. They were left highlighted per colour code (see Table 8.1. below) so that one could track what colour was associated with what mechanism. The other important function of the colour coding was to demonstrate how different mechanisms could interchange between CMO spaces in time and space. Lastly, the table helped to quickly identify what mechanisms are there for whom and how they were produced and their outcomes under what contexts.

Detailed data is tabulated. The summaries following the tables are intended to guide the reader through key concepts from data. Further analysis and discussion of the data is presented in Chapters 9 and 10.

Table 8.1: Keys for colours representing different mechanisms

Key – Colour representation	Mechanisms (reasons and resources)
Yellow 	The number of times or frequency something happened.
Bright green 	Existence of something (i.e. structural emergent property / cultural emergent property / personal emergent property).
Turquoise 	The psychological, cognitive, affective, physiological, economic, sociological, and organisational processes. - Amount of knowledge - Heightened interest - Motivations - Anxiety/ tension - Motivational responses - Choices made
Teal 	Context
Red 	Outcome
Pink 	Programme activity
	Arrow explains in-depth background of the excerpt above it.

8.2. Issue 1 - Dealing with the start of the citizen science project in a community of Mpophomeni

Table 8.2: Issue 1 - Dealing with the start of the citizen science project in a community of Mpophomeni

PHASE 1 (Nov 2011 – Oct 2015)		
Context	Mechanism	Outcome (Individual or Collective)
10 enviro-champs were working on a volunteer basis. Their tasks were to monitor sewerage manhole spillages. In 2014 each enviro-champ was managing 8-10 manholes. To do the tasks, they were all remunerated with R200 airtime. The airtime was primarily used to keep communication within the team and to be able to report sewer problems with the local municipality plumbers and authorities (Umgengi). The local municipality's primary mandate was to collect waste from the streams, whereas the Umgungundlovu District Municipality (UMDM) was responsible for managing water and wastewater. Ayanda and Thandanani alluded that most of the people in Mpophomeni own their houses, and most if not all are RDP houses. The people in	"If you can take the enviro-champs away from the project, then the activities required for the project cannot happen [the people are central to making it work]" (Ayanda and Thandanani, pers. comm, 2016) → Gathering the ten enviro-champs is a social mechanism. The quote implies that the intervention or the programme itself does not work, but the processes involved in the interpretations and agency by the subjects [i.e. enviro-champs] are the ones that produce the results and make the implementation possible (Porter, 2015a). "To be honest... some of the enviro-champs, in the beginning, were coming [volunteering] because of the R200 airtime....but as they got more involved, they developed a passion for the job and learning about the environment" (Ayanda, pers.comm. 2016) → R200 was a motivation for doing the tasks in the beginning. R200 in the realist evaluation is regarded as a socio-economic resource/mechanism which is real and external to the enviro-champs and has made the intervention possible. Over time, the enviro-champs developed a passion or heightened interest for doing the activities. This is explained as developing the agency and responsibility for playing the part and belonging to the enviro-community in Mpophomeni. Thandanani (2016) added by saying, "to me, I don't like to think about it as a stipend – but people need to get reimbursed."	The fundamental step to ensuring the implementation was to procure social capital – the ability to gather people to execute the project. They gained trust from the community. Through the enviro-champs' dedication and commitment to implementing the intervention, they built a good relationship with both the local and district municipality. → This relationship is a generative mechanism which was later structurally interwoven.

Mpophomeni have title deeds; however, others don't own the homes. Instead, they were renting those RDP⁶¹ houses. ■ They mentioned that they were experiencing many serious socio-environmental challenges in the areas where residents were renting the houses. Mostly the big challenges were illegal dumping and manhole spillage. They observed that those residents were not taking enough responsibility and accountability compared to those who own the houses. ■ They also mentioned that some owned the RDP houses as enviro-champs, whereas others did not. However, what was important to them was that they were all from Mpophomeni. However, their challenge was that people residing in Mpophomeni but not born from Mpophomeni did not care about Mpophomeni development. ■ Another challenge was that regardless of who owns the RDP houses	→ R200 in this statement is a metaphor or symbol of showing the value and respect for their volunteering efforts. It is a psychological mechanism. Ayanda emphasised that <i>"the money is important for taking the project forward."</i> → Money is a socio-economic mechanism which forms a key to doing the intervention work in the context of Mpophomeni. They mentioned that the community of Mpophomeni was involved in the project because they cared about Mpophomeni. They wanted to demonstrate their care by keeping the streets and Midmar Dam clean for themselves and future generations.	

⁶¹ RDP - the Reconstruction and Development (RDP) housing programme by the post-apartheid government for people living in poverty and cannot afford or own land.

or who was born or not in Mpophomeni, they all equally had a culture of keeping their homes clean. But the problem was that they all did not show interest in keeping the streets clean. Anything outside their fences was not their responsibility; hence, the illegal dumpsites mushroomed.		
Integration point: Sewer/ manhole monitoring activities. The enviro-champs were assigned to monitor manholes that were near their reach.	■ The community would let enviro-champs know about the manholes with problems at a distance or out of reach,. → This was a generative social mechanism [in terms of trust] within the social fabric built over time. Their work was able to influence the behaviour of the community. ■ Enviro-champs made efforts to find support from a hardware(Build-It) to get washers and supplies to help the community to fix the leaks. → They developed the agency of identifying stakeholders needed for making their tasks effectively. ■ The manholes were located and stored on a GPS device and uploaded onto a heatmap. ■ The miniSASS activities assisted them in identifying the manholes that were causing pollution problems in the streams. ■ Liz has observed that it took some time (about 1-2 years) for the enviro-champs to get used to the activities, create platforms, use opportunities and be able to apply them with confidence	Manholes were monitored with efficiency later in the project. ■ Liz mentioned that <i>"they started to feel more confident and able to participate in the war room meetings"</i>. The enviro-champs were able to participate in community setups and political structures. The miniSASS activities were mechanisms, and the outcome was the identification of problematic manaholes.

	→ The time it took for the enviro-champs to be able to do the exercises with confidence was a key mechanism to making the intervention a success. The agency developed both at the individual and collective levels.	

The first half of this issue illustrates the 'deep' background including the adversities of living in an RDP township as well as perceptions of each other, divisions and class. It should be noted that the RDP programme was designed solely for destitute, vulnerable people. The aim was to transform the substantial social imbalances by ensuring that poor and needy South Africans were provided with qualitative houses or shelter as part of their human and basic right (Kang'ethe & Manomano, 2014). The expectations are that the housing infrastructure and surroundings should meet international housing norms, which are decent and supported by social, sanitary and hygiene facilities (ibid.). However, Kang'ethe and Manomano (2014) explained that meeting these international standards has been a big problem for the South African government (context). The lack of these standards results in a gradual loss of 'ownership spirit' by the dwellers or beneficiaries. So, many would sell, rent or abandon them (outcome). It was this ownership spirit and its responsibilities that the enviro-champs were concerned about (cf. Table 8.1. above) (mechanism). In addition, being a native to Mpophomeni appeared important. It was not only external problems from the government they faced but also internal issues within the community. They suggested that a lack of ownership spirit and being a foreigner to Mpophomeni exacerbates the lack of care in their surroundings and delays development. They suggested that a native and owner of an RDP house tends to have more agency and to do more than that a foreigner and lessee. The main difference is that when one is an owner of an RDP house, one appreciates its value in all aspects, has an interest in improving its welfare and surroundings, and invests in maintaining and improving it (ibid.) (mechanism). The respondents shared further the following feelings "Some of the beneficiaries of these houses are selling these houses because they did not deserve to have them in the first place. They would not have rented or sold them if they really needed them." Regarding the value of owning an RDP house in the study by Kang'ethe and Manomano (2014): "This is because some of us had no house to call our own except these shacks and as such we cherish and embrace them dearly ... We love and cherish them because we did not have any. We are now owners of the houses" (pp. 14-15).

An interview in Kang'ethe and Manomano (2014, p. 14) revealed that "it's very painful to stay here without a job because life is very difficult, my desire is to have our government secure us a job" (context). Hence, the issue of R200 airtime and the need for reimbursement (mechanism) was stressed in the case of Mpophomeni enviro-champs – especially since most of the enviro-champs were unemployed and most had dependants. The point of money as a remuneration mechanism must not be overlooked or undermined. Life was not easy, people needed money or a similar incentive to sustain the project, and there were subtle expectations. Though they consented to volunteerism, it was not entirely relational but also transactional. Issue 2, outlined in Table 8.2. below, demonstrates

the extent of participants' actions if their basic needs and expectations are not met. They found alternatives, resulting in disrupting the intervention.

Among the outcomes mentioned above in Table 8.1., the fundamental anchor for the project's daily activities and continuity was gaining community trust and developing good relationships with government structures. Enviro-champs became trustworthy mediators. Stepping into a trustworthy mediation role was an asset for both the project and the enviro-champs themselves. This meant they became an alternative to litigation, relieving the community and government from stress, being empowered in many aspects of their lives, and becoming entrepreneurs. Regarding entrepreneurship, below in this section (cf. Chapter 8, Table 8.5), we see Thandanani Luvuno finding the opportunity to explore his street theatre skills through citizen science platforms and making an income from it.

The second part of the issue (Issue 1 in Table 8.1.) is evident at the point when the citizen science tools were first integrated into an already running project. The actual situation was that the enviro-champs were initially assigned to monitor the manholes by only monitoring leaking manholes that were nearby and then reporting them. Other citizen science tools were gradually introduced, and the above data in Table 8.1 demonstrated two fundamental changes that occurred in their practice. Bringing in the citizen science tools enabled the following for the project and enviro-champs: improved reporting efficiency and confidence (outcomes). However, to get this right took almost two years. At the same time, the uptake and use of the tools meant extra activities. For instance, it was no longer only enough to go to the nearby manhole and report any spillages, but using miniSASS, one needed to go to and be in the river, learn about the streamflow, identify and assess the source of contaminants and then report (see Chapter 7). Also, developing agency is a theoretical and practical process; hence, the enviro-champs made an effort to build other relations with stakeholders for extra resources, attending war rooms, etc. Of course, these are the perks of becoming a mediator and acquiring learning skills; however, this meant investing more time and introducing a specific way of reporting (refer to miniSASS information sheet in Chapter 7) (mechanism). This leads to examining time use, compensation, and volunteering.

Understanding the psychological connections between decision-making about money or decent compensation and economic evaluation, time use and time in terms of money, willingness and determination to volunteer, and priming to promote prosocial behaviour for the common good in the Mphopomeni enviro-champ project was tricky. Pfeffer and DeVoe (2009) argued a valid point that people exposed to hourly wage rates (understanding time for money) tend to volunteer less than those used to salaries. Somehow money can tamper with altruistic volunteerism. Given the

background in this context, the study carefully considered whether desperation could also determine the degree and extent of volunteering? In this case, not necessarily the altruistic volunteering type but also the transactional volunteering type? From what Ayanda Lepheana mentioned, most people's initial motivation to participate was R200 airtime. At the point of this study, after two years of R200 airtime compensation for participation, some had left, but many remained (see issue 2 in Table 8.3.). Both outcomes were important for retaining volunteers, especially for decision-makers and project developers. The question remained: How much and what kind of willingness and determinism should one uphold to carry a spirit of volunteerism in a citizen science project like this?

CMO Configuration Insight 1: *While the above context is complex as discussed, it seems that contextually a lack of ownership and adequate compensation in a context where there were not many other alternatives for livelihood construction (context) requires a mix of compensation (e.g. the R200 stipend) but also motivation, ownership, ethics and commitment to volunteering for the greater good of the community (mechanism) and this leads to uptake and use of CS tools in the community context.*

8.3. Issue 2 - Dealing with a financial crisis in the citizen science project

Table 8.3: Issue 2 - Dealing with a financial crisis in the citizen science project

Context	Mechanism	Outcome (Individual or Collective)
From December 2013 and January 2014, no funding was available for the enviro-champs, which caused anxiety. In December 2015, there was a substantial decline in the number of reports.	The verbal reporting on manhole spillages and blockages continued even though reports were not documented. → This emanated from choice and individual agency. This, however, affected the efficacy of reporting.	The enviro-champs could not print materials/forms to capture data on manhole spillages or blockages. When there was no funding, there were no reports. Because there was no funding, some enviro-champs left the programme and went to find jobs.

CMO Configuration Insight 2: *Decline in funding (context) reduces the efficacy of the reporting (mechanism), and also leads to losses in contributions from the enviro-champs (outcomes), even though agency and choice still allowed others to continue with verbal reporting, despite lack of funding (mechanism).*

8.4. Issue 3 - Dealing with youths and their circumstances in the citizen science project

Table 8.4: Issue 3 - Dealing with youths and their circumstances in the citizen science project

Context	Mechanism	Outcome (Individual or Collective)
Ayanda Lepheana (30 year-old man in 2016) He joined the enviro-champs through a friend who was also involved in the intervention. His task, in the beginning, was to monitor one manhole and then, over time, he got deep and actively involved with the kids' club. He was involved in managing the kids' clubs.	The recruitment network in the intervention played a crucial role in attracting those who wanted to be involved. Through active involvement, Ayanda became passionate about the environment. He was also a 2nd-year student at UNISA, and the tasks done in the club were aligned with his assignments and exams. → This was the individual agency and a motivational response for wanting to be involved in the intervention. He enrolled on the accredited courses at WESSA in line with the activities conducted in the project. He mentioned that the combination of active involvement in the project and studying accredited courses had improved his life. He attended workshops with international people, which then exposed their project internationally. He considered money – that was given as a stipend – as (existence of capital) a symbol of recognition and acknowledgement of their work.	Being actively involved with the enviro-champs activities has resulted in him being appointed as the co-ordinator of the enviro champs (after six months). In 2013 he became a facilitator of Kids Clubs [with Louine Boothway] using citizen science tools. <i>"I had more information and knowledge and was able to start and organise my trips on my own"</i> (Ayanda, pers.comm., February 12, 2016). He became competent and confident in organising and managing activities. He found the tools very useful to him. He was doing the miniSASS with the kids. The data revealed that the stream condition was getting worse each time. Through the miniSASS data, they managed to identify the manholes that have been spilling into the stream for a long time. They applied miniSASS upstream and below the stream to trace where the spillage originated.

		■ <i>"Using the miniSASS helped us a lot when we sent the data to the Department of Water and Sanitation" (Ayanda, pers.comm., February 12, 2016).</i> ■ Through the data as evidence, they convinced the Department of Water and Sanitation to take action. ■ The Department of Water and Sanitation got actively involved in the project. ■ The evidence produced by the miniSASS gave them a voice to speak to the Minister of the Department of Water and Sanitation about their water challenges in Mpophomeni. ■ They also got a chance to tell the Minister about the enviro-champ project and its challenges through the evidence. ■ The enviro-champ project has helped Ayanda find a part-time job at Umgeni Water as a water process controller and a job at GroundTruth, working currently as an ecological technician. ■ Being actively involved in the project has made him realise that many unemployed people in the Mpophomeni community and many children were orphans. And many of them "really need a meal, and they will never forget you

		[when you help them]" (Ayanda, pers.comm., February 12, 2016). He found value in his current role in the project. Also saw value beyond the project and its role in the whole Mpophomeni community.
Nhlonipho Zondo (30 year-old man in 2016) ■ Zondo started in 2011. He was a champion for six years in 2016. He was located in Ward 8, where Baba Ndlovu was a ward councillor. His home was located not very far from the dumping site. He has been observing illegal dumping over the years. Besides the illegal dumping challenge, he also noticed that the community around him did not know what objects to flush down the toilet. And he understood that all the pollution flushed in the toilet ended up in the Mthunzima stream and then into Midmar Dam, but he felt helpless. He did the Expanded Public Works Programme (EPWP)⁶² jobs and mentioned that he volunteered for the 'love' of the environment.	■ He believed that volunteering as an enviro-champ was something rooted beyond the human realm; he was born with it. As such, becoming an environmental champion came naturally to him. This trait made his job easier when helping others stop behaviours that do not comply with environmental values. His reason for getting involved in the project was because ■ "You can never live without water. Meaning if you pollute the water, how will the people live, especially pregnant women who are more at risk". He heard many dialogues about recycling, and he always wished ■ to see his community change. Every Tuesday, the enviro-champs gathered together and used the meetings for sharing progress. ■ He mentioned that they have direct contact with the ward councillor, and they could talk about their challenges even outside formal settings.	■ He mentioned that the environmental awareness and knowledge attained through the enviro-champ project helped him have the courage to make the environment around him a better place. As he said, "On Sunday I took a walk and saw a dead goat dumped in the stream. So on Monday I had a small talk with my friends, and we dug a hole and put the goat in the hole and covered it" (N. Zondo, personal communication, February 12, 2016).

⁶² The Expanded Public Works Programme "has its origins in Growth and Development Summit (GDS) of 2003. At the Summit, four themes were adopted, one of which was 'More jobs, better jobs, decent work for all'. The GDS agreed that public works programmes 'can provide poverty and income relief through temporary work for the unemployed to carry out socially useful activities" (<http://www.epwp.gov.za/>).

Here Table 8.4 reflects the experience of two males of the same age, thirty years-old, but who displayed different motivation and agency to participate in the project. Consideration of their differences could play a critical role in transforming citizen science practices. For instance, Ayanda Lepheana's motivation and approach supported his academic career and profession, and he eventually found a job aligned with them. In contrast, Nhlonipho Zondo's motivation and approach were rooted in a sacred connectedness with nature and humans. His consciousness and value for clean water enabled him to understand the interconnectedness between ecological and social life systems and new beginnings. The fundamental function of the intervention was to provoke his innate passion for the environment and help him to act on it. It is not wise to apply a blanket approach even if people seem similar. Nhlonipho's view on participation demonstrated that it is not always the case that people of this background have money or economic capital as a motivation for volunteering. As opposed to others who left the project for new job opportunities, altruism does exist and can be strong enough for one to become an environmental activist. Lastly, this exemplified that shared social experience and common social identity did not mean identical experiences or produce identical outcomes; however, shared reasoning could be an outcome (Hastrup & Hervik, 1994). In this case, both young men wanted to better their lives and those around them.

CMO Configuration Insight 3: *While people have diverse histories and backgrounds (context), they can still be (differently) motivated to exercise their agency (mechanism) in use and uptake of CS tools leading to similar but also potentially different outcomes.*

8.5. Issue 4 - Dealing with recognising those no longer in the 'youth category' in the citizen science project

Table 8.5: Issue 4 - Dealing with recognising those no longer in the 'youth category' in the citizen science project

Context	Mechanism	Outcome
Thandanani Luvuno (36 years-old man in 2016) There were new and old enviro-champs groups depending on the year they joined. The old intake started with the programme in 2011, and the new ones began in 2015. Thandanani was amongst the older enviro-champ groups that joined in 2011. He was introduced to DUCT by the local older man Mdu Mchunu. They were working together with groups of men who were political activists. They also worked with TAC – HIV AIDS projects.	"I need to survive." (Thandanani pers. comm, February 12, 2016). He found the project one of the means or reasons for enabling him to survive life. He used the citizen science tools because they were not expensive and user friendly for kids. Another reason was that the citizen science tools were helping them to locate what and where the problems were in the Mtunzima stream. The citizen science tools helped them with supporting evidence when presenting the problems to the engineers from Durban and the district municipality. "Why am I still in DUCT? I need to see the change where I am living. If I do not do it in my community, then who will do it?" (Thandanani pers.comm, February 12, 2016) → He believed it was his responsibility to take care of his surroundings because he was a citizen of Mpophomeni. In addition to the intervention, the programme managers (DUCT) could use some of the funding to entertain and motivate the enviro-champs by taking them to game reserves to see the rhinos and the Maluti Drakensberg. It was something that Thandanani mentioned they could not have been able to afford on their own. Through these outings and training, he could have a different positive perspective (environment inspired) of life in general.	Thandanani established a community drama about water issues, including water quality issues. When he does street theatre, he gets (or expects) remittance. He could make income from the street theatre. He mentioned that working with the enviro-champs via DUCT has worked for him. Looking at the relations he managed to build, the skills he developed, the responsibilities assigned, and the personal agency he developed gave him a sense of value to his community.

	■ The information acquired about water quality management through the tools was crucial; however, for Thandanani, possession of information only was not sufficient, primarily if he could not disseminate and apply it. → Here Thandanani implied that the existence of a resource is not enough if it is not usable. The essence of having information was in the application. ■ He also explained that as much as DUCT was the project manager, the people were the core resource in control of the project, and those were the people in Mpophomeni. ■ Another reason the enviro-champs were loyal to DUCT was that they both could equitably sit together to plan the project and plan how to take it forward. → Valuing and trusting their intellect, competencies and contribution during the planning session was vital for them and enabled them to implement the project better. Having to see DUCT valuing them gave them a sense of belonging. That again became a collective vision for the project. ■ He felt that being part of the enviro-champs changed his life for the better. → Seeing the socio-economic transformation in his life through the enviro-champ project gave him hope. ■ The 'small stipend' that they received has helped him sustain his life. → The metaphoric use of the word 'small' was profound because, in this case, a small thing had a significant transformative value in his life that one must not undermine.	

What is life like for the 'lost generation'⁶³ or the forgotten generation, 'shock troops', 'foot soldiers', 'young lions', etc. (Seekings, 1996), and where are they? Even assigning the term 'lost generation' is morally and politically debatable, but this is not the point here. The fundamental message this section wanted to show was that Thandanani Luvuno was one of the 'lost generation'. He stayed in the project because 'he needed to survive'. I have explained this phenomenon in the discussion chapter (Chapter 9). Here we see Thandanani continuing to survive through life. His story proved that people work for money, but they stay for other reasons such as recognition (DUCT recognising their value) and emotional motivation (DUCT taking them for excursions). Lastly, the DUCT strategy of showing care was visible and felt by him because it mattered that "before people care about what you know, they need to know that you care" (B. Howard, Founder and former CEO of Clientele Life Assurance Company, personal communication, May 3, 2022). Hence, combining mindsets in planning the project together was critical to Thandanani.

Thandanani asked, 'if I do not change my community, who will?'. The projects activated a sense of agency in initiating one's own volitional action in the community, and in return, he gained function in the community.

Much information and data were collected and organised using the citizen science tools. Thandanani admitted that they helped strengthen their case; however, the challenge was that they could not understand the in-depth and holistic meaning of the data. Thus, their knowledge, practice and learning were limited.

CMO Configuration Insight 4: *Despite being unemployed and in a context of struggle for livelihoods (context), the CS approaches that involve learning how to use tools, extend one's identity and motivation and that develop care and recognition (mechanisms) are important in supporting uptake and use of CS tools, capacity development, and professional and social learning for sustained employment and contributions to community (outcomes), as much as income generation options are (mechanisms). When both work together (i.e. income generating opportunities and identity, competence and confidence development), then better and more sustained outcomes appear to result.*

⁶³ 'Lost generation' is a youth generation who were radical, military and civilian, and were disruptive to apartheid rule, committed to live in the violent streets of South Africa to help build structures of people's power, liberation cultures and democracy (Seekings, 1996).

8.6. Issue 5 - Dealing with the uptake and use of the citizen science tools (and techniques) in the citizen science programme

Table 8.6: Issue 5 - Dealing with the uptake and use of the citizen science tools (and techniques) in the citizen science programme

Context	Mechanism	Outcome
Sewer/ manhole monitoring – target number was 60 manholes (at least one manhole for each member).	All the manholes had GPS coordinates and were laid out on the Google Earth map app. At the beginning of every month, the enviro-champs were supplied with forms to be filled in with information daily. At the end of the month, they collected all the forms and then arranged them into spreadsheets. The form's layout: they had a picture and names of the enviro-champ responsible for the manhole's information filled in.	■ Pivot tables provide a substantial amount of information, e.g. spilling, fixed. ■ They have developed a Google Earth map using the GPS coordinates to illustrate the information. They would insert a colour coding layer on the map to display the severity of manholes spillage based on what information was reported.
Walk along the Mthunzima stream (usually on weekends).	They made observations and learned about the stream, further enhancing the experience.	By so doing, they were monitoring the outflow from the Howick sewage plant.
■ They used the educational poster (refer to Appendix 12) as one of the citizen science tools.	They used their own understanding and knowledge about the streams and learned further about the surrounding social-economic activities affecting them.	■ The aim was for the enviro-champs to engage the community participants by critically identifying and assessing the good and bad decisions and activities occurring around the streams and predicting future implications. ■ The poster's images enabled discussions and comparisons about the activities occurring in the poster's streams and Mpophomeni streams. It allowed them to think deeply and critically about the impacts of their own decisions and actions on

		the streams. By so doing, conversations about water quality management emerged and ideas of how to combat their poor choices started.
■ The uptake and use of miniSASS were introduced to the enviro-champs through the Eco-Schools programme. ■ At the beginning of the project, the stream sites selected to conduct miniSASS were too polluted and the enviro-champs were not allowed to touch or get into the stream for six months, waiting for dilution. ■ The foul-smelling water of Mthunzima stream could not be ignored. It was smelly because the sewage was spilling into it. ■ Kids were conducting the mini SASS exercises every second Saturday of each month. This was done during the organised kids' walk.	The support from Eco-School made the application of mini-SASS easy for the enviro-champs. Making judgement and waiting for favourable conditions were vital for applying the mini-SASS. ■ Testing the water quality through the mini-SASS tools was helpful to the enviro-champs for scientific evidence purposes. ■ Each enviro-champ would lead and be responsible for the maximum number of 15 kids per group. ■ Each enviro-champ was supposed to meet with the kids every Friday. And they were responsible for teaching them about the environment and how to use the citizen science tools introduced to them.	■ Around January 2012, they saw a crab. That was a good indicator for water quality improvement. They were all excited and gratified. ■ The data from testing the water quality has resulted in one of the Department of Water and Sanitation officials personally visiting Mpophomeni to inspect the manholes and their challenges. ■ Some of the members thought dealing with the environmental issues was overwhelming, far-fetched and beyond one's comprehension. But when they started using the citizen science tools, they realised that the local environmental goals could be attainable. They observed that some required little behavioural and attitude changes and small amounts of dedication daily. ■ The citizen science tools helped the enviro-champs to - improve their reporting methods, - enabled them to organise excursions with kids clubs,

		- empowered the enviro-champs with the knowledge to communicate and assist the community better. ■ As Thandanani mentioned, "Before we had the tools, the enviro-champs were just reporting the manholes. There were no trips with the kids. They got empowered with knowledge through the training so that they can help the community". ■ During the walk, the enviro-champs would gather together with their kids for discussions [the last group who took a walk included 96 kids, all from Mpophomeni).
Door-to-door environmental awareness	■ The (20) enviro-champs were able to discuss the community's environmental challenges. They were also discussing the social issues the community faced. ■ Every Tuesday, there was training on what was needed for the door-to-door activities. → The knowledge and confidence gained through training and running the activities enabled them to explore other social-ecological issues of the community. ■ After their work gained traction from the community. The enviro-champs worked with the schools around the project sites. Gaining access to the schools became easier. As one of the enviro-champs during the International Citizen Science Workshop, Feb 2016 mentioned, ■ "For the project to be sustainable, we need to get people's buy-in. It is better if they initiate it rather than going	The community became aware of the enviro-champs work and mindful of the surrounding environmental concerns. ■ The street drama team was established. The street play focused on the customs of the use of flushing toilets. Public events were implemented through drama. ■ Through the street drama, the performers from the enviro-champs were publicly known as "the man of the toilet". This was when awareness manifested.

	to the community, commanding them to join us in our venture. When they start it themselves, they feel a sense of ownership. In that way, they will sustain the project.” → Through their involvement with the community and schools, they managed to help the community and the schools develop collective and individual agency. After all, they intended to gain the trust of the community. ■ Because the drama performers from the enviro-champs were community members and always present and easily accessible to the community, It was manageable for the community to start many conversations, including the social and environmental issues, at any time, in many different settings. E.g. It could be children walking in the streets, going to church, and sharing their experiences about what they learnt from the street theatre. → The street theatre lessons were gradually implanted in them; as a result, they became aware and enculturated in their everyday habits.	
The enviro-champs used mobile smartphones for GPS coordinates to locate manholes and analyse the ones with problems.	■ The GPS could only be used via smartphones and needed the internet to operate. ■ When they did not have access to the internet during the stipend cut-off, they could not connect, upload data, or assess what was going on with the manholes. → The existence of a resource such as a smartphone and a secondary one such as internet access were essential to enable the enviro-champ to locate the manhole problems and analyse the patterns over time.	■ The GPS coordinates were collected, manually captured on the excel spreadsheets and plotted on the Google Map. The map was important for telling a story about water pollution occurring in the Mthunziwa stream ■ "the map showed that something is happening in Mpophomeni that is making our stream and our dam dirty and affecting the future" (Ayanda, pers. comm. February 12, 2016).

		 Working with the map and seeing its value in making awareness about the water problems in Mpophomeni has given Ayanda more reason to remain an enviro-champ.

Table 8.6 has highlighted how the more the enviro-champs take up and use citizen science tools, the more they require or apply different skills and decision-making, and the more efficient the reporting. At the same time, the more they took up and used the techniques, the more time was required to execute the exercises. The reporting became a daily activity.

Four other features that stood out were : (1) the extent of their determinism and willingness to make the uptake and use of the tools work, despite the health risks during their visits to the streams when pungent, foul smells due to sewage spillage were high; (2) bringing the community together using the educational poster (see Appendix 12) to find and analyse problems together and find solutions by themselves; (3) influencing the decision-makers and developing agencies of government officials to make the change they wanted; and lastly, (4) making little dedications resulting in little changes each time. Thus, success was found in the little things.

Furthermore, the fundamental issue discovered was one of the root causes of manhole spillage. When flushing toilets were introduced into the community, they were not educated about objects permitted to be flushed down. Hence, the blockage of sewage pipes occurred often. After creating maps and assessing them, they could see that something was happening in the community that affected the streams but they could not locate exactly what and why. This was a critical point: though manhole spillage can have a physical-infrastructure cause (a quantitative reason), how and why (the qualitative reasons) manhole spillage was happening was complex for them to locate and understand.

CMO Configuration Insight 5: *The environmental conditions (poor water quality and manhole leakages) (context) were a reason for using a diversity of citizen science tools , with more and more tools being used (mechanism) that offered empowerment to communities as well as deeper insights into the problems and their causes (outcomes) .*

8.7. Issue 6 - Dealing with the political structures and cultures in and of the Mpophomeni community where the citizen science project was implemented

Table 8.7: Issue 6 - Dealing with the political structures and cultures in and of the Mpophomeni community where the citizen science project was implemented

Context	Mechanism	Outcome
The political context for participation in Mpophomeni: When the Minister visited the Department of Water and Sanitation in Durban in 2012, she had heard of the enviro-champs work. The enviro-champs had built the relationship with the Department through a particular government official. As a result, when the Minister visited Midmar Dam, she decided to also visit Mpophomeni and met the enviro-champs. She heard about the challenges of the dysfunctional sewage pipes that caused sewage spillage into the streams, and immediately the following week, the new sewage pipes were delivered and installed. Department of Water and Sanitation built a relationship with the enviro-champs via Nompulelo and Siyabonga (DWS government officials). The relationship started in 2014 when	Politically, in KwaZulu-Natal, particularly in Mpophomeni, "you can't do anything without going to the war rooms"⁶⁴ (Thandanani pers.comm, February 12, 2016). Through the project, the enviro-champs managed to build a good relationship with the ward councillor; as such, they were given some discretion on who they must recruit, etc. Zweli Mkhize⁶⁵ built a structure in the Umgugundlovu district in the war rooms, which was regarded as a success because it allowed local people the freedom to raise the challenges they found in their ward. The war rooms were designed to raise issues and allowed local people to share their work. For instance, those in a war room higher management recognised the enviro-champs' work about door-to-door activities. It was an achievement for the enviro-champs. Everyone in the group, the new and old enviro-champs, could attend the war rooms to collect information or report their project.	The councillors were known to have a bad name in the community for nepotism. As such, they were constantly under scrutiny. Through the enviro-champs project, they were able to share the responsibility with them, in particular when selecting the candidates for the project → This has helped the municipality to regain the trust of the community. People, including the international visitors, who visited schools around Mpophomeni were creating recognition of the enviro-champs and their work. In June, 2012, the sewage spillages were all fixed. It was the first time in the project's history that zero spillage was recorded.

⁶⁴ A war room is a room in politics designed for holding meetings for local communities to participate and engage with the government. It is used to gather activities that are happening because need strengthening from the government, gather information, ideas, plan strategies, direct activities, etc. of the organisation and guides activities for political campaigns.

⁶⁵ Dr Zweli Mkhize was a member of the ANC. Amongst other units he served in the ANC, he was responsible for developing the country's health policy and was the ANC chairperson in KZN.

the two government officials visited Mpophomeni to launch the 'Adopt the Stream' programme. They were looking for youths to employ for the Cleaning the Stream project, i.e. collecting litter along the streams. They were looking for people who already had the understanding and training in environmental care. Hence, the enviro-champs were the ones that were recommended because of their background in caring for the streams. ■ There were perceptions about the only way to influence the local municipality or a community's attitudes and decision making. ■ "If you were a white person coming into the community, they would not want to know you because you were perceived as the opposition party member. To date, I have asked myself why. We have a network and connection with the local municipality, so we forced them to work with the whites, but it was taking a long time" (Thandanani pers.comm., February 12, 2016)	■ The spreadsheets in the enviro-champs report had some questions related to engagement in the war-rooms. ■ The challenge in the war rooms was that the enviro-champs needed to be introduced, and it was only after they were recognised that they could contribute. If they were not recognised, their comments would not be taken seriously. ■ At the war rooms, enviro-champs were recognised via WESSA because of their involvement in Eco-Schools. ■ The door-to-door activities have led to DUCT being recognised in the community. ■ Thandanani was a political activist. Through his involvement with the government and understanding of government processes, the DUCT officials and the enviro-champs built a peaceful relationship with the local municipality and the community in Mpophomeni. → Thandanani's position in both the community and government was regarded as a mechanism responsible for influencing the change in behaviour of both parties. This made the process of building relationships easy. ■ The municipality officials started to pay visits to sites the enviro-champs were monitoring. They would bring other managers to assess the problems. → The amount of time taken to understand the enviro-champs projects and the number of visits to where they conduct their activities have influenced the government officials to take the enviro-champs work seriously.	Midmar Dam seemed to be "clean" at some point meaning it had commendably improved. ■ In Dec 2015, sewage blockages started to decline. The working conditions and understanding of the enviro-champs project developed a harmonious collaboration between the community, DUCT (NGO), government and the enviro-champs.

As shown in Table 8.7, the enviro-champs' work demonstrated the power of recognition and agency in influencing decision-making. The kind of recognition that showed their hard work was valued in the project. Many positive outcomes were observed in how they went above and beyond the expected performance and plotted strategic approaches for developing agencies of others, including the government officials, NGOs (run by white people) and the community.

As Thandanani Luvuno mentioned,

If you were a white person coming into the community, they would not want to know you because you were perceived as the opposition party member. To date, I have asked myself why. We have a network and connection with the local municipality, so we forced them to work with the whites, but it was taking a long time. (T. Luvuno, personal communication, February 12, 2016)

This phrase is explained in depth in analysis Chapters 9 and 10. Thandanani was well informed about how the war rooms operated, and he instigated strategic moves on how to take advantage of them to benefit the project.

Due to recognition of their hard work and strategies, enviro-champs were better positioned for new opportunities. In the end, they were able to bring together government, NGOs and the community in one setting for harmonious cooperation for the benefit of all. The collaboration meant improving the performance, commitment and accountability, development efforts and lives of the community of Mpophomeni. This confirmed that a bottom-up approach is possible in political spaces if there is willingness, determination and support.

CMO Configuration Insight 6: *The socio-political context and its operations (context) are an important consideration in the effective uptake and use of CS tools. In this case active participation in, and familiarity with the local socio-political structures and mechanisms facilitated trust building (mechanism) and uptake and use of the CS tools in the community decision making processes (outcome).*

8.8. Issue 7 - Dealing with the NGOs and project developers in the citizen science project

Table 8.8: Issue 7 - Dealing with the NGOs and project developers in the citizen science project

Context	Mechanism	Outcome
From the NGO's point view: Liz from DUCT discovered quite soon that Mpophomeni had many people involved in many different community things within the Mpophomeni area. Mpophomeni was a vibrant place with many 'activism' clubs, churches, etc. There were always people who stood up for a course in each organisation. And those people were community champions. That was why she found it easy to find enviro-champs in Mpophomeni. To have an effective and functional government and public services, Liz mentioned that it needed "the pressure a bit from local people – need to put some pressure on the councillors". In the project's second phase, the enviro-champs could attend accredited training.	Liz used the already existing [political and] cultural agency of the <u>community's intuition</u> to help and the community's feeling of needing to engage in community matters. She mentioned that "We would invite Sbu Khuzwayo [the municipal manager for uMgungundlovu District Municipality] in the early days. And we would write a long list of organisations to join, such as the local municipality, district municipality, midlands meander, NGOs from Mpophomeni and NGOs from beyond, invite councillors, plumbers, DUCT, - we would go through this very carefully". This was a list of a few stakeholder networks that the project needed. Their political will was necessary for sustaining the project and effecting meaningful collaborations and change in the community. As they advanced, to make the work of the enviro-champs easier, Liz mentioned that "Mpophomeni need to have a fenced area with a concrete base that is properly managed at strategic points [to prevent waste from scattering all over the place including in the streams]". This was a response to building sustainable domestic waste management to prevent them from polluting the streams. Jim Taylor from WESSA mentioned that to put the enviro-champs on the map, "it would be good to document the training courses the enviro-champs have done" to see how they link with other career pathways.	Jim Taylor further mentioned that the outcome they noticed generated by the enviro-champs' work was the "manifestation of a learning society", which was a tick in a box for them as the project developers. He said that "If the people don't learn, they will not grow" (Jim Taylor, pers.comm., February 10, 2016).

Liz Taylor's observations in Table 8.8 that referred to the historical and cultural models centred around volunteerism and altruism of the Mpophomeni community were profound. Analysing them reflexively, they generate multiple meanings. To make sense of these meanings, I draw ideas from Hervik (1994) in Hastrup and Hervik (1994). He argued that as researchers who study community cultures to make improvements or interventions, we need to be careful or rather understand the interviewees' social positions. He mentioned that we need to see beyond what people do and search for their intentions. For instance, Liz's observations showed that a citizen science project is strongly reliant on volunteerism and altruism for the common good. To see them already as an integral part of the community's culture was helpful for the project because this meant less effort and resources were needed for developing their agency. But the issue with this kind of volunteerism and altruism needed by the citizen science project was that one did not know the degree to which they were transactional, relational and organic. For instance, the Mpophomeni community could not have known or been clear about the economic value of their volunteerism and altruism compared to their social value.

In their book, Hastrup and Hervik (1994) argued that knowing contexts' history and culture is not enough primarily because cultural understanding gained through observation can differ from those understandings of the community who lives there. Fully gaining social experience and anthropological knowledge of communities involves embodying the rules and structure and understanding and putting the cultural experiences into action (which resonates with the ubuntu philosophy discussed in Chapter 3). They explained that the reason why knowing and making observations were not enough was that it is not only a matter of empathy but also "a matter of systematically probing the practices that go without saying in those unfamiliar zones of experience that we choose to study with all our senses" (ibid., p. 57). These include cultural model applications in action. Acquiring cultural knowledge and participation in community life provides a context for the correct usage of words (i.e. meanings). This means there is a big difference between documented knowledge about the reality of people (as an observer) AND living and doing with people. Thus to understand their reality, one needs to live their reality (ibid.) or be fully converted (as Mbiti (1969) explained with ubuntu cf. Chapter 3), or at least be partly involved in that life, even if for a limited time. By doing so, the researcher, project developer, and participants become a learning society. As Thandanani Luvuno explained, he enjoyed being part of DUCT project because DUCT allowed them to plan and make decisions about where they wanted the project to go. After all, the enviro-champs understood the context best because they lived with the challenges. For the teachers in the Vaal-Triangle project, the school management and project developers wanted to involve them in planning the teachers' development programmes. In the beginning, the process of involving the participants was as valuable as continuing to be involved on the ground with them as the project progressed. Thandanani further explained this by saying that

researchers (and project developers) must not only come to research but also stay with us within the community to support us economically and experience their lives.

Research must contribute to everybody's understanding rather than just being extractive. For instance, they must contribute to our local economy by booking accommodation at the Mpophomeni tourism experiences. (T. Luvuno, personal communication, February 12, 2016) (cf. Table 8.10: Issue 9)

In this way, a learning society could be achieved as per Jim Taylor's aspiration. Thus, a learning society can cross the boundaries between 'them' who live and practise and 'us' who observe, emphasise, document and research; researchers need to become people who live and practise together in a community, even if it is for a short time.

CMO Configuration Insight 7: *Every community has its own socio-cultural background and experience (context) which is important to fully understand and recognise, and value in the process of developing CS tools uptake and use processes (mechanism), this deepens mutual understanding and can contribute to a learning society where everyone can learn from each other in the spirit of ubuntu (outcomes).*

8.9. Issue 8 - Dealing with the second cycle of the citizen science project

Table 8.9: Issue 8 - Dealing with the second cycle of the citizen science project

PHASE 2 (Nov 2015 – Sept 2018)		
Context	Mechanism	Outcome (Individual or Collective)
Volunteerism was based on "working full-time" (Ayanda, pers.comm., 2016). In this second phase of the project, the enviro-champs were paid R102 per day and worked 22 days a month. The aspect that Thandanani wanted us, as realist researchers, to be cognisant of was that some enviro-champs have children, meaning that they have family responsibility beyond the environmental and social responsibility. The enviro-champs were asked how their project was different from other community projects in Mpophomeni. Ayanda mentioned that they were like other groups in many ways even though they tackled various issues. What made the enviro-champs programme different was that they made efforts to collaborate with others, including other projects. For instance, they were working with the group called Place of Hope for the orphans. They mentioned that some of the NGOs in Mpophomeni have been operating for many years (up to 15 years). These NGOs have a history and relationship with the Mpophomeni community, where they raised many children. As a result, many community members are willing to do community	20 Enviro champs were the resources. Enviro-champs linked their project with other community groups' projects around Mpophomeni to teach the children water quality management. As they learned about the project, they realised that environmental issues, specifically water and social issues, are interlinked. Developing a collective agency by working together with other projects was key to ensuring a meaningful impact on the Mpophomeni community. The innate culture of the Mpophomeni community of wanting to help others and themselves held the community together and made the work of the enviro-champs easy.	The enviro-champs who had children were empowered and gained the confidence to help their children with the homework, which was more important to them. They felt empowered because of the knowledge and training through the enviro-champs project. This became one of the reasons the enviro-champs stayed in the project. They developed a collective agency to resolve social and environmental issues connected to water quality.

work with them. However, as Thandanani added, "The problem is that these [community groups that exist in Mpophomeni] groups work in silos. Authorities do not want to work together. They want to keep the identity of different projects". They also mentioned that the culture of Mpophomeni community of desiring to do community work could be found in other neighbouring communities even if the issues they tackled were different. It meant caring in the enviro-champs is not unique, and they noticed the same attitudes and culture in the neighbouring communities.		

In the second phase of the project, from 2015 to 2018, the enviro-champs were ‘**employee volunteers**’. This meant they were working full-time, 22 days a month, though not assigned any job titles and were still simply ‘volunteers’. Being an employee volunteer has benefits and downsides. On the one hand, the enviro-champs were now promoted to occupy 'unknown positions' that were regularly paid R102 per day – i.e. employment. This changed their families' economic status, from no income.

Around 2015/16 in South Africa, the national minimum wage was about R4 161 and the working-poverty line was R4 125, or R166.44 and R165 per day (i.e. divided by 25 days), respectively (Isaacs, 2016). The enviro-champs ‘salary’ was about R2,244 per month (i.e. for 22 days). They were under the working-poverty line by R1386. This comparison was necessary to show that while projects like this study could help appropriately reduce working-poverty rates and inequality to support the Mpophomeni community to cover the basic needs for themselves and their families (ibid.), there is a need to develop funding models beyond the stipend.

CMO Configuration Insight 8: *In a context of general marginalisation and unemployment, but where social cohesion, agency and the will to work together was evident and present (context), the project enabled broadening and deepening work with water issues within the community through community collaborations and through limited employment funds. This was illustrated by joining already existing projects to optimise impact (mechanism). Working together with other projects was innovative because it brought a full spectrum of community members and outsiders to bring collaborative solutions. It also empowered the enviro-champs to become confident parents in their children's lives. Due to these benefits and values, many enviro-champs remained in the project. At this point, the spark of a learning community was observed (outcomes).*

8.10. Issue 9 - Dealing with the research ethics for researching citizen science projects in a community setting like the Mpophomeni community

Table 8.10: Issue 9 - Dealing with the research ethics for researching citizen science projects in a community setting like the Mpophomeni community

Context	Mechanism	Outcome
Thandanani and Ayanda opinions about research conducted in Mpophomeni: ■ Thandanani mentioned that he didn't have a problem [with outsiders doing research in Mpophomeni]. But he noticed over the years that community members "think that you [researchers] extract information from us but... why is it that researchers don't thank us for our time? There is a feeling in the community that people[researchers] come and use [exploit] them. Researchers need to be careful and treat people with respect. Particularly, they need to acknowledge that people are busy [occupied and engaged in things concerning their livelihoods]. They need to understand that if their interviews are longer, more than 15 minutes, they need to reimburse to compensate for their time". ■ He continued to say, "Research needs to contribute to everybody's understanding, rather than just being extractive. For instance, they must contribute to our local economy by booking accommodation at, pay to stay in the Mpophomeni tourism experiences." ■ Thandanani mentioned that funding is critical for taking the work of the enviro-champs forward. If there is no funding,	■ The overall mechanisms that they mentioned that made the project possible were that: - Everybody got the project's T-shirts, - They provided food occasionally, - They had excursions, - The enviro-champs could do two drama plays each month, - They received R200 per person - who was involved in the drama plays, and the transport was being paid for, - Louine from Eco-Schools was involved full-time in the beginning. She linked the enviro-champs with the eight eco-schools she was working with, - The enviro-champ drama crew got the opportunity of training with the Durban theatre groups at the Durban University of Technology. The collaboration lasted for two years. - The Green Trust funding enabled the enviro-champs to attend accredited courses. - They regarded the Green Trust funding as a good funding model because it was flexible in moving small amounts from one budget line to another.	These resources, reasonings and choices, over time, moulded the structures to be unique to their case and changed cultures of operations that led to the project's success. Collectively, they formed new systems that can constrain and enable the choices of those continuing with the project.

people would only volunteer for a short period only; as such the volunteering is not going to be sustainable.		

As shown in Table 8.10, Thandanani Luvuno challenged the value creation that most research in Mpophomeni has not been experienced as transformative even though data illustrated gradual transformations in the micro-personal level of enviro-champs and other individuals connected to the project. Still, at this level, the impact was not clear on the extent of the growth, distribution, change of livelihood and sustainability. He questioned the effects and efforts of research (and researcher) and how it actively and intentionally needs to promote social and economic development at (a) both the macro-community and micro-personal levels (Mertens, 2017) and (b) in everyday situations for broader well-being (Blocker & Barrios, 2015). Otherwise, local social and economic growth will always be narrow, unsustainable, and exploitative without consideration of the levels of transformation. Thandanani's idea of transformation was to see the enviro-champ participation as contributing to research that adds and facilitates the co-creation of transformative value in transforming the historical structure and patterns of Mpophomeni agency and development.

Not only did Thandanani question the transformative value research should provide (as an outcome), but also research in itself should be transformative (its processes and practice). In transformative research, reflexivity needs to ensure its methodologies do not inhibit its agency. Also, Thandanani challenged the systemic view of social research ethics, the influence and role of government and institutions, social (quantitative and qualitative) research and programme evaluation research.

Lastly, the fundamental ethical mechanism needed to drive citizen science projects in the context of Mpophomeni was to have a decent funding system that is flexible.

CMO Configuration Insight 9: In a context where the history of science research has primarily been exploitative (context) there is need to strengthen researcher reflexivity and co-engaged approaches to CS research, as well as better funding systems to support co-engagement in research processes (mechanism) to better facilitate engagement with the uptake and use of CS tools and thus more inclusive meaningful participation in CS research practices (outcome).

8.11. Issue 10 - Dealing with the decision-makers from the municipality ward's⁶⁶ point of view in the citizen science project

Table 8.11: Issue 10 - Dealing with the decision-makers from the municipality ward's point of view in the citizen science project

Context	Mechanism	Outcome
From the councillor's point of view The ward councillor recognised and acknowledged the enviro-champs' work: "The enviro-champs did a lot through the intervention, Liz initiated. They have made a lot of successes" (councillor, pers. comm, February 17, 2016) The councillor wished the work of the enviro-champs could penetrate the rural areas or wished they could do similar projects in the rural areas. The rural area community (especially women) still do laundry in the small streams passing through. He felt there was a need to teach them how to care for their streams. The councillor acknowledged that the issue of funding for projects like the enviro-champs' was a problem, especially at the municipality level. As a result, the lack of funding limits the sustainability and efficacy of the project impact. He mentioned that "for change to happen in Mpophomeni to a better township, we need to work together and communicate. Identify all	The municipality had their own programmes, and the enviro-champs had their programmes. The municipality, consolidated both programmes into one. "Even though the enviro-champs are the ones who do great work" (councillor, pers. comm, February 17, 2016). The training that the enviro-champs received was vital because it empowered them to communicate with the municipality better and convey messages to the communities. The municipality considered the enviro-champs leaders or champions in the community because of their project. As a result, it was easier for the municipality to introduce them to the public or schools. They attended meetings in which their presence was crucial for the municipality. It was important because they could raise their needs there. The councillor mentioned that he, too, learned a lot from them.	The councillor was commending the enviro-champs work and was considering increasing their number so that they could cover a larger area. He also thought of adding an environmental education programme to the project. He recommended that WESSA, DUCT and the enviro-champs must invite him to the meetings, especially if they need assistance from the municipality. An important citizen science technique that worked well for the enviro-champs was drama in the form of a play. This was because it attracted many people, the information was easy to disseminate, and people could relate easily. However, it needed funding to carry on. The significant change that the enviro-champs were able to bring to the Mpophomeni community was to unblock the sewer pipes.

⁶⁶ In South Africa, wards are geopolitical subdivisions of municipalities used for electoral purposes.

those things that are bringing down our community. And we need to have a mechanism (s) for dealing with all these things" (councillor pers. comm, February 17, 2016) ■ The things that the enviro-champs have done so far in terms of strengthening their project was - To get the leadership of the municipality involved, - They maintained good communication with the municipality, - They brought the municipal officials on board, - They communicated their projects, explaining their challenges and their needs.	■ He recommended that all councillors work with the enviro-champs in their wards and support them. ■ He was aware that most of the councillors were on board initially, and for the enviro-champ work to be sustainable, the enviro-champs should continue to ensure that they put them in the loop all the time that they can continue to be involved. ■ He mentioned that "as a councillor, you cannot do everything. You need Liz, you need these groups [enviro-champs, for example] to help the community because it is part of the service delivery". ■ He also mentioned that he sometimes provided the enviro-champs with a slot to talk about their projects in the public meetings.	

As shown in Table 8.11, this section exemplifies the interventions that transformed a community-driven development programme through the enviro-champs. Many values were realised through their participation in governance, e.g. enabling, strategic, and applied values. They were empowered and treated (by themselves and government) as reliant assets and partners (i.e. tools) for the developmental processes of water quality management issues in Mpophomeni (Dongier et al., 2003). When given support and resources, the enviro-champs were determined to organise themselves, identify and address challenges, increase effectiveness, and enhance a working together spirit that helped strengthen governance and improve service delivery.

However, community driven development is not a fix-all tool that can be applied indiscriminately to all contexts, nor does it in any way replace the need for the kinds of structural transformations in developing countries that will create new industrial and service jobs, provide technical services that lie well beyond the communities' purview, and promote other large-scale improvements to human welfare. (Wong & Guggenheim, 2018, p. 3)

The question remains, under what circumstances and at what costs, and for how long can what kind of participation from the Mpophomeni enviro-champs be enough to reap meaningful benefits? Despite all, there is a need for procurement of decent funding to sustain the project and improve the welfare of the enviro-champs meaningfully.

CMO Configuration Insight 10: *In a context where water quality issues were serious and governance systems were experiencing difficulties with service delivery (context) the collaborative approaches of the enviro champs to co-learning with municipal officials and sharing of information and support was appreciated (mechanism) leading to better collaborative governance at a local level around CS practice and water quality management (outcomes), although this could be further enhanced with more sustainable funding models (mechanism).*

8.12. Issue 11 - Dealing with the overall collective impact of the citizen science project in Mpophomeni

Table 8.12: Issue 11 - Dealing with the overall collective impact of the citizen science project in Mpophomeni

Context	Mechanism	Outcome (Individual or Collective)
Group interview Some of the Mpophomeni community members thought the enviro-champs were wasting their time volunteering on this project. They initially received nothing for compensation; that is why some community members did not take them seriously. Despite the community's disparagement, the enviro-champs still did not get discouraged. Instead, they continued with the project. Liz kept encouraging and advising them to be humble, as humility could get them through hardships, insults and attacks. They mentioned they too realised that humility has indeed helped them. Another issue they needed to address about the citizen science project to the community and in their meetings was that the project was not run by or affiliated to any political party. They mentioned that the trick to persevering in the course of this project was to be 'nice' to the community members regardless of the circumstances. They figured out that striking back at a bad situation by throwing back a bad attitude would not take them anywhere.	Some enviro-champs mentioned that they volunteered because they wanted to see Mpophomeni look neat and decent like it used to back in the olden days. Some enviro-champs volunteered because they felt they were playing their role(i.e. a [moral obligation) in the community by passing environmental knowledge onto younger generations. They were happy to take walks with the kids and do miniSASS activities. The end goal for them was to witness their involvement in changing the perception and lives of the children of Mpophomeni community. Another method for making the door-to-door practice effective was interacting with the community members and providing them with pamphlets that they could refer to daily. Each house was allocated ten minutes for interactions. Sometimes the discussion diverged from the environmental problems. The community members would talk about their children and their social challenges. During the 10 minutes, the enviro-champs were supposed to take pictures of leaking pipes or leaking taps. Pamphlets were another mechanism for ensuring that information stayed with them for	The establishment of the enviro-champ project became a starting point for the Mpophomeni community to change their attitude toward the environment, specifically water quality management. The community members started to become whistle-blowers, too, for solid waste and manhole spillage. They started consulting and reporting to the enviro-champs. They, too, started to see the environment differently and positively. The old enviro-champs group discovered that the new enviro-champs group emulated them to adopt how the more senior group did things. The relationship and trust between the enviro-champs and the plumbers became stronger and the plumbers ultimately trusted their judgement and responded immediately to their calls. The enviro-champs have established another volunteering group that deals with fixing pipe leakages in people's houses. Even though they did

■ Before the enviro-champs project was established, it took the municipality weeks, months, and sometimes even years to reply to the community's complaints. Some community members reported that they had pipe leakages for two years. ■ When they started presenting their challenges in the war room, some municipal stakeholders, e.g., SASSA, got interested in their work. They were fascinated by the door-to-door method. ■ During the door-to-door intervention, the enviro-champs discovered information and challenges not connected to water issues. Old grannies staying with their grandchildren were not receiving pension funds or sometimes not receiving children's RDP grants. They were able to link the stakeholders with people who needed their services through the project. ■ The challenge they faced with one of the projects, Adopt a Stream, was that they would collect the rubbish from the stream and put this into garbage bags. Then the municipality would not collect them; as a result, the garbage bags would lie in the field for a long time, where goats and dogs would quickly spread the rubbish all over again.	reference since 10 minutes was not enough for sharing all the information. War rooms played a significant role in reporting their project progress and challenges. ■ Baba Cele stressed that the use of the cell phones was crucial. In addition, the need for good cameras to take pictures was also critical. For this smartphones were required. ■ Through the Door-to-door intervention, the enviro-champs made petitions about problematic and dissatisfying public service delivery issues outside of water issues. They got them signed easily and then took them to the Umgeni municipality. Liz from DUCT helped them to draw up relevant documents and letters.	not have enough tools, they ensured sharing of the few they had. ■ Occasionally, the enviro-champs would find community members, particularly older people, with no money nor resources But they would fix the leakages anyway. ■ Whenever there was a need to buy washers for fixing the leaking pipes, they would search their pockets voluntarily and buy them. ■ The enviro-champs' dedication and commitment to the environmental championship have influenced the community to recognise the value of their work. Some community members are even interested in joining them. ■ The enviro-champs felt that their project eventually gained value from the community and has helped everybody in the community (whether the community was aware of the benefits or not). ■ The drama plays gained traction from the community and schools. ■ The enviro-champ project was not only limited to water-related issues but also taught the community about how to live healthily and learn about different types of healthy food.

		■ The enviro-champs observed that the amount of clean water running down the street has immensely reduced since the intervention. There were no more manholes spillages, and solid waste was also reduced. ■ Occasionally they would catch community members who still did illegal dumping. One of the enviro-champs recalled that "this other day I asked this other person not to do illegal dumping because the municipal truck was going to collect them, but she went ahead anyway. I took a photo and then told Baba Cele. He went to talk to her, and she was very sorry."

Some of the Mpophomeni community members thought the enviro-champs were just wasting their time volunteering on this project. They initially received nothing for compensation; that is why some community members did not take them seriously. (A. Lepheana, personal communication, February 12, 2016)

As shown in Table 8.12, much of the volunteerism and civic service in Mpophomeni was shaped by the political context, and associated traditions and cultural history where motivation was initially intrinsic for social relations (ubuntu) and promoting democracy (Hunter & Ross, 2013; E. Taylor, personal communication, February 9, 2016; T. Luvuno, personal communication, February 12, 2016). It seems gradually that extrinsic factors, such as compensation for volunteering, were becoming a much stronger motivation for participation in projects. Otherwise, even for the common good – e.g. increased quality of life purported by volunteerism work (Salamon et al., 2011), committing time and energy was viewed as a waste by some. The in-depth causes of such reasoning could not be determined; however, the fundamental message here was that compensation for time and energy is a method to optimise volunteer use – especially considering the unemployment and poverty prevalent in Mpophomeni.

On the other hand, for some enviro-champs, virtues such as humility, ubuntu and kindness, helped them remain and sustain their participation. The biggest motivation was that they wanted to live in a place of dignity. Satisfying basic human rights like living in an area with access to sanitation and clean water is a concern for human dignity. Hence the environment, the state and the community must ensure that this happens. This depends on understanding of collective responsibilities and relationships with others. Furthermore, being apolitical about the project's agenda, understanding the community's relationships with the outside social interventions, and the trust gained from the community through being their social and environmental championship, empowered them to be resilient.

The citizen science project and its flexible interactions with the community helped unearth other community social ills, e.g. social grant issues, and resolve them. Enviro-champs were able to identify and connect various responsible stakeholders. By so doing, they demonstrated a holistic view of water issues and their central interconnectedness to the Mpophomeni community's livelihood.

Citizen science project methodologies have increased the efficiency and efficacy of the public service delivery. In the process, they have identified drawbacks in the municipality's management performance. War rooms have strengthened political participation in decision-making. At the same

time, smartphones have helped enviro-champs participate better using technology; becoming better at fixing leaking taps and pipes has also enabled their technical participation.

The enviro-champs' tenacity built on community agency has supported more stakeholders to become part of the community. Also, within the enviro-champs themselves, the second intake group learned and adopted the first intake's ways of doing things because they had worked well. Their perseverance developed characters that brought hope to the community in general.

CMO Configuration Insight 12: Careful engagement with the complex contexts of politics, water quality, and community commitment to the common good and democracy (context) and use of creative innovations in the CS context that are contextually relevant and valued can strengthen intrinsic motivations (agency and commitment to society well-being and the environment e.g. through volunteerism) that can be further extended by extrinsic motivation (funded practices) (mechanisms) that can then lead to many positive outcomes when CS tools use and uptake are supported within a holistic and agency centred development approach that builds on community strengths (outcomes).

8.13. Summary of Chapter 8

This chapter has considered a number of complex dynamics of the CMO configurations and has offered further CMO Configuration insights. As can be seen, they differ from those presented in the previous chapter.

The chapter has illustrated that mechanisms (reasons and resources) can be fluid and can, at one time or point, become a context, in another, an outcome. They can interchange and/or be the extension of the intrinsic and extrinsic factors, evolve with time and space and history, and have a direct and indirect influences.

The chapter has explored some of the adversities of dwelling in RDP townships like Mpophomeni. It unpacked the systemic, cultural and traditional issues here and their implications for individuals and collectives, enviro-champs and the general community. Though motivation to participate varies (external factors like compensation and internal factors like ubuntu), the enviro-champs and community showed determination and willingness to work and improve their land when supported, acknowledged and trusted.

Whilst youth development and women empowerment were necessary, prioritisation and inclusion of the 'lost' generation (between 35 and 50) was fundamental. Many, like Thandanani Luvuno, could not actively participate in current economic activities due to being systematically, economically and politically disadvantaged by apartheid. Black men like Thandanani are particularly vulnerable.

Furthermore, as much as the project was about the uptake and use of citizen science tools, the data demonstrated it was also about the creative and innovative techniques (e.g. door-to-door initiative) and attitudes applied with the tools that made the project a success. Additionally, involving political structures such as the war rooms and engaging other stakeholders such as SASSA empowered the enviro-champs and the community, making a bottom-up approach in decision-making possible.

NGOs or outsiders as cultural behaviour observers were fundamental in seeing relational resources (e.g. volunteerism) that could be converted into social and economic value (when supported), aspects that insiders would not have picked up. However, the conversion and making those resources usable, a procurement of decent and sustainable funding and the formalisation of the recruitment process, e.g. 'employee volunteer' (or doing away with the term 'volunteer'), are at the core of the growth of the community interventions such as those in Mpophomeni.

Lastly, reflexive considerations of the volunteers' background and their aspirations in project philosophies, planning, implementation and management processes were found to be the drivers of the desired outcomes, giving meaning and relevance. Hence, in its depth, this reflexivity challenged the extent to which systemic governance of volunteering effort/labour is just and ethical when working with disadvantaged communities and the enviro-champs of Mpophomeni.

The next two chapters discuss the findings of the study further.

CHAPTER 9

DISCUSSION OF THE ENVIRO-CHAMP ISSUES: TOWARDS A MORE COMPLEX UNDERSTANDING OF THE CMO CONFIGURATIONS

9.1. Introduction

The aim of the Chapter 8 was to present and surface issues that revealed some of the dynamics of the CMO configurations relevant to the Mpophomeni project, enviro-champs and the citizen science tools. In this chapter, I develop a more complex understanding of the CMO configurations as the work of a realist evaluator is not just to surface CMO configurations, but to interpret them with more depth to strengthen the understanding. This interpretation helps to deepen the hydro-sociology and hydro-hegemony insights of the study, and it sheds more light on the issues of public participation and power relations that were surfaced in Chapter 1. I do not offer the same interpretation of the CMO Configurations of the Vaal-Triangle teachers case, as much of their issues have been described in terms of the strong influence of the educational structures in Chapter 7. The Mpophomeni experience was much more complex and interesting to discuss, hence I focus on this in Chapter 9. In Chapter 10 I return to both case studies.

As noted various times, this study is an in-depth realist evaluation of the uptake and use of citizen science tools – its purpose is not simply to confirm issues, CMO theory or to surface CMO Configuration insights (as was done in Chapter 5-8). Rather it seeks depth of interpretation. There is therefore need for more depth discussion and evaluation of the issues involved, and care is needed in describing and explaining why, how and under what circumstances the uptake and use of tools occur rather than disapproving the choices of the choice makers (Porter, 2015a; Sharpe, 2011). Providing a contextual understanding within which programmes like the citizen science programme of this study function can provide insights to policy-makers and decision-makers which could help to improve policy decisions and understanding on what and how programmes work effectively (cf. Chapter 1). By effective, I mean the value(s) a programme brings – socially, economically and sustainably and under what circumstances. As indicated in Chapter 1, the knowledge of how and what works effectively in programmes under what circumstances (for ethical, social and educational justice) was a concern for this study. Insights from the analysis may be of value and the learning from the findings of this study can bring hope and evidence that can feed into improving and strengthening government and NGO interventions and policies alike.

Secondly, the reason for developing a realist evaluation of these issues was to bring a **methodological approach for citizen science programme evaluations** to the fore. It is hoped that it can inform planning and implementation theory for citizen science water quality management programmes. This methodological approach of what to consider in a context of a citizen science practice can be essential for bringing forth the evidence and mechanisms that can measure the effectiveness of the (planned and emerging) sustainable outcomes (i.e. results). In the mechanisms, one can at least trace what input brings what actual improvements and the actual impact of change, rather than simply focusing on measuring and monitoring the activities or process indicators (Mbava, 2017). Noting this approach is essential in community of citizen science practice, particularly since the value of citizen science practice is becoming evident in South African mainstream science and water management policies (DWS, 2017a, 2017b, 2017c – also see Chapter 1). Not only can the approach assist in the citizen science practice evaluations, but it can also help make the localised process of a bottom-up approach to large-scale water management policies and plans feasible, for example the National Evaluation Plan of 2018-19 to 2020-21 (Department of Planning Monitoring and Evaluation, 2017). It can also help mediate understanding and knowledge of the broadness and complexity of socio-ecological systems.

9.2. Discussion of issues related to the Mpophomeni case

In the section that follows I discuss mechanisms linked to each issue involved in the uptake and use of the citizen science programme from programme theory and CMO points of view in the Mpophomeni case. This discussion extends the initial CMO Configuration insights offered in Chapters 8 showing up the detailed complexity of the CMO configurations. I discuss each of the issues presented in Chapter 8.

9.2.1. Discussion Issue 1: The start of the citizen science programme in a community setting like Mpophomeni

The starting part of the intervention and its underlying situation, which included the root cause of the problem, was pivotal to scrutinise because sometimes the context in which the programme started determines the programme outcomes. This is because programme mechanisms / social mechanisms (i.e. resource and reasoning) are theory incarnate, which means they are preconceived ideas from programme developers who may have predicted how things may work out (Porter, 2015b). On the other hand, human agency of subjects of the programme, i.e. enviro-champs, is ultimately responsible for changing or maintaining social and programme activities (i.e. cultures and structure) and outcomes depending on how they interpret the programme mechanisms (ibid.). Porter (2015b) continued to argue that those programme mechanisms are only capable of providing social enablers and constraints that can influence the reasoning and plans because, in themselves, they do not consist of

a trait of human agency. But for a realist evaluation, one needs to see how they both relate and operate to understand what generative mechanisms they trigger to produce what kind of outcome(s). For this reason, I investigated the beginning of the programme and the programme design. There were a few mechanisms I intend to highlight.

- ***The people – the enviro-champs – as both social and economic resource***

Porter (2015a) mentioned that the intervention or the programme itself does not work. The processes involved in the interpretations and agency by the subjects (i.e. enviro-champs) are what produces the results and make implementation possible. This resembles the views of Thandanani Luvuno:

If you can take the enviro-champs away from the project, then the tasks required for the project cannot happen [the people are central to making it work]. (T. Luvuno, personal communication, February 12, 2016)

The context of who they are or the kind of people they are in terms of social and economic positioning in the community was an aspect that needed deep interrogation. As shown in this study, the kind of mechanisms they triggered in response to the intervention resulted in outcomes like gaining access to the community's and the municipality's trust. **Building trust** has been shown to be at the core of citizen science projects of this study (A. Lepheana, personal communication, February 12, 2016).

The programme's subjects (enviro-champs) must be acknowledged as both social and economic resources for enabling the uptake and use of citizen science tools. This is primarily because of their extensive understanding of the Mpophomeni surroundings, the water problems and they are the ones with (and expected to have) the agency(s), ability to negotiate values, social powers, and manoeuvre cultures required to bring about change and transformation.

- ***At the heart of civic volunteerism is the social and economic reasoning for participation***

Initially, the motivation for some of the enviro-champs to participate was to receive R200 airtime – the immediate value (Wenger et al., 2011a). As they *gained the capacity and capability to participate and build the learning community*, they became aware of the *potential and generative values of participating* in the programme and *the power(s) they held in sustaining* the citizen science programme. Those powers included how their civic skills and competencies gained trust from the community and the political structures like the municipality and built a close relationship with them. The attention they received from the municipality became a powerful tool for many reasons of

participation that surfaced in other sections but relevant to this section was *the chance for their voice and interests to be represented in the political and decision-making spaces* of Mpophomeni.

Another gain from civic volunteerism was that the enviro-champs became passionate about the programme activities and developed agency and wanted to learn more about the environment, in general, that affected their surroundings. However, the more knowledge and passion gained meant more choices and more experimentation, and through those processes, they gained the ability to influence change. All those implied greater responsibilities, accountabilities and more time and resources needed to implement the project.

On the one hand, enviro-champs stretched the boundaries of the citizen science project (the intent of the project), which is good and exemplified the potential and transformative ripple effect the project created. On another, this research has interrogated the culture of volunteerism, specifically the time invested and expected and efficacy in time, i.e. time in terms of money and resources. Ultimately, it meant doing more with little, often multitasking and stretching too thin. As a result, at the core of doing civic volunteerism and participation there is a self-imposing effect of not realising the actual reality of their capabilities and resources such as time, money, and skills (Brady et al., 1995). These insights help decision-makers and project developers to think deeper about these probabilities and prepare for them. These things are inevitable because of the connectedness of water issues to other socio-ecological concerns in an open system like the Mpophomeni community.

Even if there is determinism, volition and becoming active voluntarily, the problem is that choices will always be limited by the programme capacity and social conditions required to participate and create change effectively, if the groundwork is not well prepared (Porter, 2015a). Thus, even if the citizen science programme of this study was based on volunteerism, money or funding is necessary for meeting their needs and the needs of the programme. The enviro-champs are active agents in the programme and the social settings they live in and various resources including monetary compensation are necessary to support them.

▪ ***A value of gratitude and care (human agency)***

Regarding the R200 airtime (which later became a stipend of R102 per day for 22 days/month) Thandanani said, "to me, I don't like to think about it as a stipend – but people need to get reimbursed" (T. Luvuno, personal communication, February 12, 2016). This statement meant that the heart and efforts of volunteerism should not be taken for granted or imposed. Programme developers must look

at money or stipends and go beyond considering philanthropic and altruistic values to show care for the enviro-champs' quality of life.

The enviro-champs mentioned that their reason and the community's reason to participate in this programme was because they care (i.e. altruistic) for Mpophomeni township mainly because they lived and were born in Mpophomeni. They felt a sense of belonging to Mpophomeni. And because they belong to Mpophomeni, they care not only for themselves but also for future inhabitants of Mpophomeni. However, they addressed how the different *types of belonging (belonging by being a native/citizen and belonging by being a resident)* to Mpophomeni affected different *levels of care/altruism* to the Mpophomeni community and water issues, and its future socio-ecological systems.

- The hint of who is born or not in Mpophomeni seemed to be an essential element of social context that shows the kind of prior social perceptions and interrelationships they have amongst each other in the Mpophomeni community concerning the care of the water issues (and the surrounding environment in general) that can limit the efficacy of the programme mechanisms. The enviro-champs suggested that those who are only residents and not born there do not care enough about what happens to the future of Mpophomeni. This unpacks perceptions of who holds what degree of agency for change and what interventions are needed for whom.

This was an important feature to explore, especially when thinking of environmental justice in Mpophomeni and the meaning of future and sustainable 'good' water quality management and governance and the fulfilment thereof.

▪ ***Integrating a 'formal' volunteering intervention into an already existing vulnerable context***

The European Charter for Volunteers defines a volunteer as,

a person who carries out activities benefiting society, by **free will**. These activities are undertaken for a non-profit cause, benefiting the personal development of the volunteer, who commits their time and energy for the general good **without financial reward**. (Porcano, 2012, p. 7, my emphasis)

Herd and Meyer (2002, p. 674) argued that American unpaid care work within families by women must be at the

forefront of [formal] civic engagement and be considered a form of civic action, though this civic activity must be voluntary and altruistic in nature, while simultaneously nurturing

reciprocity, social ties, and social trust ... it must be **unpaid and only indirectly related to the state.**

The two quotes above offer a common understanding of what formal volunteering should look like and can be used interchangeably in describing informal volunteerism – which is central to the research problem of this study. Throughout the study, the notion of understanding formal volunteerism was considered as an activity or work that must not be paid while contributing towards social and political development. Elsewhere, in sections 7.2, 10.2.2 and 10.2.7, I explained the relationship between **informal volunteering**, free will, social obligations and agency, how they fall short if not supported economically, and their implication for the intervention progress. Hence, here I further unpack the challenges of **formalising volunteerism** that are rooted in the tension between individual free will and social obligation. Secondly, this study is concerned with this notion of formal volunteerism as unpaid work. Lastly, the argument presented is supported by considering the socio-economic and political background, and cultural systems that the participants of this study bring into the debate. It is essential to take note of such nuances, explicitly considering the growing need to “understand the contribution of formal volunteerism to poverty reduction [in academic and policy fields]” (Lewis, 2015) in African societies. I intentionally extracted these quotes and associated them with their respective countries to contribute with insight regarding how and why these definitions of volunteerism might work in some countries (e.g. the USA and Europe) but not others (e.g. South Africa). Another nuance introduced by this study is that not all volunteers in the youth development projects are youths. And not all youths are the same; for example, not all are the same age, or have the same agency, or have created the same meaning regarding volunteerism, etc. (cf. Chapter 8, Tables 8.4 and 8.5). As such, contextualised formal volunteering is necessary, especially to accommodate communities such as the Mpophomeni enviro-champs in South Africa.

There is a growing concern about the misunderstanding of the concept of (formal) volunteering and its dynamics in social development research with or for vulnerable and poverty-stricken communities in Africa (e.g. Kenya, Zimbabwe, South Africa) (Lewis, 2015; Madziva & Chinouya, 2017). Even though the level of poverty may differ regionally or geographically, what was found prevalent and had a long history in the humanitarian fabric of these communities is the value system of *the spirit of ubuntu - the mechanism that enables informal volunteer participation and cultural capital*. This value system, ubuntu, is based on developing and nurturing “the social obligation discourse rather than individual choice” (Madziva & Chinouya, 2017, p. 1126). Research in academia or social development is unclear and often overlooks this reciprocal relationship. Hence, there is a need to differentiate formal from

informal volunteerism. If formal volunteerism is applied appropriately, it can further be explicitly distinguished from low-paid work (Lewis, 2015). Thandanani Luvuno's concerns below supported the above claims when he said

To me, I don't like to think about it as a stipend – but people need to get reimbursed.

.... Because I am coming from a poor background, it is important for you researchers to recognise that, if I spend fifteen minutes with you then you have to provide tea ...and more than fifteen minutes you need to provide lunch or something... Because the time I spend with you to do interviews is the time I could use effectively by looking for a job or something that will help me put bread on the table at the end of the day.... (T. Luvuno, personal communication, February 12, 2016)

Thandanani further mentioned that he was a breadwinner in his home with many dependents. His decision and implications to volunteer were not for himself alone; others were affected. He also asked who would change Mpophomeni community conditions if he did not do something about it. By saying this, he expressed a sense of obligation to do something for his community. Considering Thandanani's background and applying ubuntu and empathy, he did not have the privilege of participating (for long) without being reimbursed.

A view on formal volunteerism as work without payment cannot work for Thandanani – Madziva and Chinouya (2017) argued that volunteerism is usually possible for those who already have access to basic needs and materials, like clean water, food, health care, some form of backup income, etc. Even though commitment can exist, the problem is when volunteering becomes time and financially demanding and has expectations such as deliverables – i.e. becoming formal. Hence, Thandanani emphasised the value of empathy when doing research with or on poor communities like that of Mpophomeni (T. Luvuno, personal communication, February 12, 2016). Empathy is a principle of ubuntu, and it goes beyond emotions to enacting it in practice, something that the EU view of formal volunteerism has overlooked. This has been adopted by the citizen science project in the Mpophomeni community and was demonstrated by the small amount of stipend or when no stipend was received.

From this study and the Zimbabwean and Kenyan studies (Lewis, 2015; Madziva & Chinouya, 2017) previously discussed, empathy and 'volunteering' or rather inherent free service were developed when the community themselves informally identified their own needs and solved them. I intentionally use the concept of inherent free service rather than volunteering "because informal volunteers do not self-identify as volunteers" (Lewis, 2015). The motivation for informal participation is inherently not associated with **financial gain**. This differs from social development formal

volunteering approaches because of their embeddedness in the poverty mitigation or reduction realm; in themselves they are expected to be a stepping stone to financial or poverty relief (ibid.), particularly considering unemployment as a critical contribution to poverty. Hence, enviro-champs such as Thandanani Luvuno, like the volunteers from Kenya and Zimbabwe, considered volunteering as low-paid work and were hopeful for better opportunities (via developing networks) through the volunteering intervention. The latter emphasises that communicating transparently to volunteers about the intervention and its financial benefits is not enough to sustain formal volunteering participation in these contexts.

Lewis (2015) further explained that the issue of motivation in informal and formal volunteerism as a critical factor affecting the effectiveness of the intervention is as important as the issue of scale. In informal volunteering, the more the group grows or diversifies, the more the **trust** is shaken within and outside the group, and the '**solidarity capital**' becomes loose; the two then become a constraint for growth. He further explained that the psychology behind informal volunteering is likely to be motivated by '**altruistic reciprocity**', whereas formal volunteering is driven by '**strategic reciprocity**'. The two approaches are essential for managing inclusive, agile, and sustainable volunteering in public intervention, like the citizen science project of this study and in the context of Mpophomeni enviro-champs.

9.2.2. Discussion Issue 2: Dealing with the financial crisis, as strategic reciprocity, in the citizen science programme



Figure 9.1: The impact of the lack of funding on the intervention
(from Ayanda Lepheana's presentation International Citizen Science Workshop, Howick, February 11, 2016)

In the UN General Assembly resolution 57/106, 142 member states have requested stakeholders to support volunteerism as a valuable resource for socio-economic and environmental development, specifically in Africa and at the community level. It was with the understanding that for achievement of the SDGs that is inclusive and sustainable, especially at the community level, volunteerism could be a strategic resource (UN Volunteers, 2009). The UN views on volunteerism (quoted in the next paragraph) conflated altruistic reciprocity founded on trust and solidarity capital and strategic reciprocity based on material gain and inclusivity (Lewis, 2015). The two require differentiation as far as support is concerned. The Mpophomeni case study has indeed demonstrated that altruistic volunteerism can work and has the potential to achieve the SDGs on a smaller scale, but only 'to some extent and for the time being'. Hence, sustaining the intervention needed a strategic reciprocity approach. The impact of the funding crisis on the enviro-champs and the programme demonstrated this, which made me question a few aspects of their form of 'volunteerism'. I observed how the financial crisis affected the agency, reasoning and response and led to division amongst the enviro-champs – between those who continued volunteering and those who left to find jobs. This event suggested a need for a more robust building of volunteer management capacity for sustainable socio-ecological development impact.

The concern was about the meaning or description of volunteerism in the context of environmental sustainability from both the global level point of view and its meaning from a South African point of view, mainly in the Mpophomeni context. The UN Volunteer (2009, p. 1) definition of volunteerism is "an expression of people's willingness and capacity to freely help others and improve their society [resilience and cohesion]" (my emphasis). It can also be described as an activity that is conducted out of a free will, done with little or no financial reward and performed for the common good (Graham et al., 2013).

In these two definitions, there are three key elements: **willingness**, **capacity** and **free** (altruistic values). Firstly, volunteering is a choice influenced by motivation (Brady, 1995; Pawson, 2006; Porter, 2015a). The choice of wanting to participate in a programme is in itself constrained by social structures and cultures (Brady, 1995; Porter, 2015a). As a result, Pawson (2006) mentioned that in programmes, choices are never an action/activity of free will. Thus choices are always constrained by the already existing context(s) (Porter, 2015a). So relying only on 'altruistic' volunteerism to achieve sustainable development – i.e. sustainable water quality management – is not sustainable. Graham et al. (2013) suggested that policies for volunteering need to be strengthened and supported in terms of dedicated

budget and infrastructure for volunteering (i.e. strategic reciprocity) and constructive state civil society relations.

'Volunteerism' was assumed to be 'easy' because of its natural embeddedness in most African individuals and most African communities and cultures (due to traditional cultural beliefs and practices rootedness) (Graham et al., 2013; UN Volunteers, 2009). However, it is not sufficient to sustain both the programme implementation and the livelihood of those involved, in particular for those from the context of Mpophomeni. This is not only because of their poor economic background that volunteerism was unable to sustain them in the programme but also because lack of it or rather lack of participation via volunteerism affected capacity, productivity and outcomes. It was demonstrated by seeing the enviro-champs not writing reports or capturing the documents' data during the programme's financial crisis. These two activities – scientific reporting and data capturing – were critical activities or tools in the programme needed for evidence in citizen science practice to influence or challenge decisions.

At the same time, as the realist evaluator, whether the programme outcomes were identified as satisfactory or not within the constraints of funding or voluntary participation cannot be the only concern; I should also be concerned about under **whose or what expense were they achieved** (Graham et al., 2013; Porter, 2015a). Since volunteering carries direct and indirect costs, such as transport and time and “lost opportunities to search for work or the need to pay for childcare” (Graham et al., 2012, p. 12). Porter (2015a) mentioned such a concern deals with the issue of value judgement which is implied by the questions ‘for whom?’ or ‘for whose benefit?’ The general question Pawson and Tilley (2004) developed for a realist evaluation was ‘what works for whom, under what circumstances, and why?’

Going back to the earlier point about how some enviro-champs went to look for jobs, while others remained in the programme during the funding crisis, raised concerns about the influence of causal powers or mechanisms from the structure (social or programme) which existed independently from individual's agency. This study has shown that there is causal power within the individuals, contrary to what Pawson and Tilley (1997) alluded to about how causal powers resided in the social relations and organisational structures they form. So it became evident that the structural constraint (i.e. funding) did trigger individual agency differently, merely because of different reasoning and resources, and choices and capacities.

9.2.3. Discussion Issue 3: Dealing with youth⁶⁷ and their circumstances in the citizen science project

Africa is currently experiencing enormous change around several challenges, including rapid economic growth occurring at the same time as escalating youth unemployment (sometimes due to lack of skills and competencies), at the same time as a declining number of elders (Graham et al., 2013). South Africa is excluded from this phenomenon, including in Mpophomeni. The population proportion of youth versus elders in the list of enviro-champ volunteers was evidence for this point. On the other hand, one would argue that perhaps the programme may have been set up in a way that favours youths over elders, even if the conditions of volunteerism were not explicit but by virtue of the activities required, e.g. walking by the riverside with kids (this issue will be explored in the next section, issue 5). Having fewer elderly members might affect the transfer of background understanding of water issues in Mpophomeni, based on knowledge and history of the community. That, however, was not the point I wanted to highlight here. The youth of Mpophomeni including the enviro-champs were experiencing both unemployment and associated poverty issues. Opportunities like the enviro-champ programme then became a platform of hope for self-development in terms of material gain. Material gains included financial gain, gaining relevant skills aligned with their plans for furthering their education, and ultimately increasing their employability chances in the mainstream economy and then securing employment (Ayanda Lepheana's story).

In addition, the enviro-champ programme provided a platform for using their desire and agency to find identity and purpose from belonging or becoming a productive member of the community, basically living the value of ubuntu (Nhlonipho Zondo's story). Nhlonipho cared for the community and the common good and felt obliged to do something about the water situation in Mpophomeni: "You can never live without water. Meaning if you pollute the water, then how will the people live, especially pregnant women who are more at risk." He highlighted that participating in the enviro-champs programme meant having direct contact with the ward councillor (who is a decision maker). They could talk about their challenges even outside formal settings.

Another issue that Nhlonipho Zondo highlighted was the issue of poor water quality affecting genders differently. He spoke of how poor water quality affected pregnant women negatively. Women's voices in this case study of Mpophomeni were not heard merely because of how randomly the participants were selected. However, in the earlier case study of the Vaal-Triangle primary school teachers, more insights were discovered in this regard, as most of the teachers were women. It was evident that young

⁶⁷ In the South African context, the National Youth Policy 2009 – 2014 youth (RSA, 2014) is defined as people between the ages of 14 and 35, and this is the same description used in this study.

people were aware of the levels and complexities of the impact of poor water quality in their community. Here, it was apparent that poor water quality does not only affect different ages or motivations for participating but also affects gender. These aspects are necessary for the decision-makers to consider when investing in young people volunteering in citizen science programmes.

From Ayanda's and Nhlonipho's story, the study identified two different individualistic motives or forms of agency, i.e. **to gain skills to further education** and **find life purpose**. They both contribute to and influence differently the collective goal or agency of achieving the sustainable management of water quality through the uptake and use of the citizen science tools. Identifying different needs or cultures of volunteerism in this study for youth was essential for the programme planning and evaluation.

There is a difference between finding a job and creating a demand market for the skills acquired in the volunteering programme. Hence, a strategic reciprocity volunteering approach is necessary for these kinds of interventions.

9.2.4. Discussion Issue 4: Recognition of those no longer in the 'youth category' in the citizen science project

Thandanani Luvuno's age group (around 30 years-old, and six years older than Ayanda Lepheana) was thought-provoking, specifically if the aim was social and educational justice. I will briefly dissect why his age group needs close attention in particular when involving them in programmes like this one.

Considering the findings, Thandanani's context was substantially different from that of Ayanda's or Nhlonipho's. The significant visible difference was linked to his political interest. I remember how well-informed he was and that he understood the influence and culture of politics of Mpophomeni and was very involved in them (refer to Issue 6). He was a political activist and noted the main reason for being involved in the programme as "I need to survive" (T. Luvuno, personal communication, February 12, 2016).

His generation was around 15-18 years-old in 1995, when the ANC won the first democratic elections, and it was the time of the beginning of the 'new' 'democratic' world in South Africa, where policies were starting to be designed for the 'new' era for all. It was the time when a process of 'normalisation' was 'expected' from all South Africans, and where African blacks were granted rights, etc. (Manzo, 1992). Thandanani's generation had been part of the Bantu education system defined by apartheid. His perception of school was influenced by the culture of how schools were used, i.e. a place for political organising and resistance (Dolby, 2001). Thus his reason for being in school was "to survive",

being resistant to the apartheid regime. At this time, inequality was a norm, and he understood politically that to reach equality, there was a need for recognition and respect of each other's capabilities, as is evident in statements like "as much as DUCT was the project manager, the people were the ones in control of the project, the people in Mpophomeni" and "another reason why the enviro-champs were loyal to DUCT was that DUCT and them sat together to plan the project and plan how to take it forward". During apartheid this would not have been possible and would have been viewed as taboo.

The culture and structure of governance at that time was that a black African man ought to find employment at the age of 15 years (Orkin, 1998). When the implementation of new policies began, Thandanani was around 20 years. However, he managed to get to Grade 12/ matric, the last class at the secondary school. His perception was that he ought to find employment after finishing matric immediately.

Thandanani's way of understanding 'survival' was not only individualistic but also intertwined with what he believed his value to be in terms of the sense of belonging in the community and the roles and responsibility he played or were expected of him in the Mpophomeni community. This is supported by this statement: "Why am I still in DUCT? I need to see the change where I am living. If I do not do it in my community, then who will do it?" (T. Luvuno, personal communication, February 12, 2016). Thandanani demonstrated that not all volunteerism is driven by only the 'altruistic notion of free will' at the fore but also by a sense of obligation and duty in society.

Thandanani also mentioned that "participating in the enviro-champ programme has changed his life for the better" – some of the funding was used to reward and educate enviro-champs by taking them to game reserves to see rhinos and the Maluti Drakensberg, which they would not have been able to afford. These outings and other training opportunities gave him a different positive perspective (environment inspired) of life in general. He also benefitted indirectly through the income he could make from the street theatre inspired by being in the enviro-champ programme (T. Luvuno, personal communication, February 12, 2016).

In summary, Thandanani turned 39 in 2019. He lived in a RDP house with his family; he has not yet acquired tertiary education but has a Bantu Education matric. The skills and competencies he has were dominated by experiential learning and are mostly in politics and street theatre. He was an adult black man with seven people depending on him in his household, of which three were in school. He might

have acquired a few community development certificates such as from the Expanded Public Works Programme (EPWP). But, he was no longer considered a youth anymore, meaning he no longer qualified for all the opportunities that are attached to the category 'youth', such as that of the National Youth Development Agency (NYDA) (2012) and National Youth Science Programme at DST-NRF SASTA. The opportunities available for him mainly required a tertiary academic profile, or a business intellect and economic capital. Citizen science project developers need to consider and cater for participants from this kind of background should they want them to volunteer in projects like this. Having human agency and moral obligations for the common good might not be sufficient and sustainable for those who are agents of change, in particular, those with background similar to Thandanani. Remuneration also needed to be critically considered as, for him, the enviro-champ 'small stipend' was required to sustain his livelihood (T. Luvuno, personal communication, February 12, 2016).

Highlighting Thandanani's background had substantial value in retelling his generation's story because their present and future in South Africa are currently often forgotten and overlooked (refer to StatsSA, 2018 - Quarterly Labour Force Survey). They are the generation that is now forced to be 'every man for himself' and they are in limbo. Programmes like this are necessary to assist people of this generation. At the same time, they must be able to empower them with the skills and competencies that are necessary for them to 'survive' or 'sustain their lives'. Otherwise, ideas about sustainable development, the common good, etc., may not find a home with them. It is a serious concern because even STATS SA overlook this generation, treating every adult the same. Neglecting or generalising that population may give a broken impression about identity, free will and volunteerism – their voluntary activities may be entirely motivated by social expectations and duties (Everatt et al., 2005). Thus, there is a need to differentiate between the political society, civil society and (democratic) millennial society (youth) and the benefits when volunteering in citizen science projects.

9.2.5. Discussion Issue 5: Uptake and use of citizen science tools (and techniques] in the citizen science programme

In this section, this study was interested in responding to the question of '*What is in the citizen science tools that enable or constrain the uptake and use?*' This question responds to the part of the realist evaluation core interest in *what works for whom and why?* with a view to responding to the main research questions:

- ✓ What citizen science tools were available, and which ones were regarded as 'generalisations' for application into diverse contexts? And why?

- ✓ What were generative mechanisms used by the enviro-champs in the uptake and use of the citizen science tools to reach what outcomes? Mechanisms which can be 'retroduced' (their existence is inferred), 'intransitive' (they exist whether or not they are detected) and 'transfactual' (they are enduring, not transitory). (Scambler, 2012)

The fundamental focus of the evaluation study in this citizen science programme was that its ontological understanding was never a straightforward process, especially in this section. Because this section formed a connecting thread to all issues of this chapter, going back and forth between them was inevitable. It wasn't easy separating the causal and emergent mechanisms of the what from the who questions in a programme theory. The what is the interpretation made by the who. The who has different layers in the following possibilities and it can either be:

- the who meaning the enviro-champ members, or
- the who representing the programme developers, or
- the who meaning government/decision or policy-makers, or
- the who referring to the domain of the global community in sustainable water quality management.

Nonetheless, this study introduced the who, i.e. the causal and emergent mechanisms (either enabling or constraining) of the enviro-champ members, within the actual, empirical and real structures/cultures, agency and relations in the uptake and use of the citizen science tools for sustainable water quality management.

Despite the complexity of disassembling 'the who' from 'the what', as a realist evaluator, I must differentiate **what works** (at the **micro-level** - meaning in the uptake and use of the citizen science tools and techniques) from **what works (macro-level – upscaling)** for sustainable water quality management in the citizen science practice. And further, it is important to consider where the two can converge.

It was, therefore, essential to see how the uptake and use of the citizen science tools were integrated into the already existing techniques of the programme that enabled them. What I meant by this was that when the citizen science tools (refer to the introduction above) of the study were introduced, the enviro-champs were already in a manhole monitoring programme. This means that the enviro-champs were already familiar with information and communication and technological skills, such as using GPS, capturing data and documenting it on pivot tables, and designing maps. They were able to do this and

interpret the results, and could often identify the cause or the origin of the problems. Through these activities, they took it upon themselves to take walks along the stream to observe, learn and verify the water quality in the stream. This means the science of doing the citizen work was already implanted. In the early days, while not necessarily considered a 'citizen science programme' yet, citizen science practices were already evident. This shows that some programmes may not necessarily be labelled citizen science practice as there may not be a citizen science name attached. But other programmes, such as the community development programmes like the Mpophomeni Sanitation Education Project (MSEP) can have characteristics of citizen science practice even when the initial conceptualisation did not have citizen science in mind. As a result, the uptake and use of the citizen science tools was familiar to them when it was introduced. Therefore, the MSEP programme was, in itself, an enabling mechanism for easy reception of taking up and using the 'citizen science tools'.

The Mpophomeni Sanitation Education Project (MSEP) served as the **preconditioning mechanism** for creating a comfortable reception for the enviro-champs to take up and use the tools. It also served as a contextual mechanism for triggering the human agency and **trust** (between the enviro-champs and community, and between the community and DUCT) – the trust that they have the technical competencies and confidence to do the work – to validate that their altruistic efforts have not gone unnoticed (Luhmann, 2000). The capabilities attained through the MSEP programme, including the EPWP work, are often overlooked or misunderstood merely because of their lack of sustainability impact. Still, in this study, we can see how they can open opportunities for other programmes that could sustain the programme and those involved. The MSEP programme did not only impart labour-related skills, but also helped build trust between communities and stakeholders. **Building trust** was a principal value needed for sustainability in a citizen science project of this kind. This finding demonstrated that it is not always the case that one programme alone can carry through and have the ability to sustain itself. Instead, it is these layers of the interconnectedness of programmes and programme mechanisms that maintain a project.

Building on the Mpophomeni Sanitation Education Project (MSEP) for enviro-champs indicated the importance of finding possibilities and linkages of sustainability especially linkages that exist between programmes and between different scales. This offers evidence that an idea alone is not sustainable, but the connections between programmes could be. Sporadic programmes that are not connected can be problematic. It ought to be noted that the purpose of realist evaluation was not to see if the programme works or not but to see what mechanisms were triggered and what outcomes were produced.

As much as Information and Communication Technology (ICT) skills were necessary giving the enviro-champ an advantage in this kind of voluntary work, there are also significant challenges associated with ICT. As observed, for the enviro-champs to capture information, they needed mobile phones, specifically smart mobile phones. They also required access to the internet. Increased access to ICT, specifically smart mobile phones, is in demand to respond to rapid changes in Africa to develop the socio-ecological, educational and economic activities. This can also affect the role and forms of volunteering in society (Graham et al., 2013). Graham et al. (2013) argued that "organisations involving volunteers need to consider how these trends manifest locally and how they shape volunteer involvement" (p. 5). The following Figure 9.2 is an example of the trend of technologies entering Africa, the focus being the energy-water nexus.

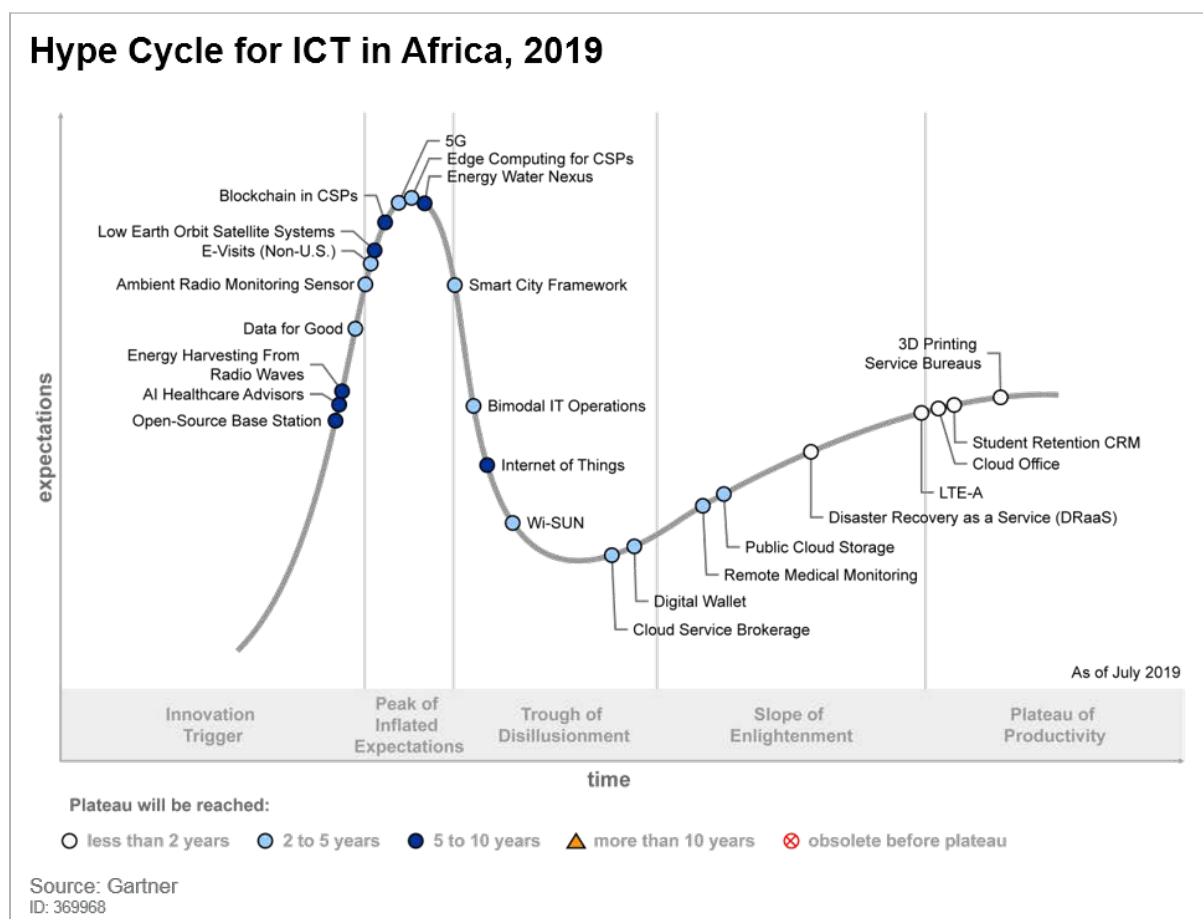


Figure 9.2: Gartner Hype Cycle for ICT in Africa, 2019 – a roadmap of technologies entering African businesses, and most are already explored globally

According to the South African Insurance Association (SAIA), South Africa is leaning to explore 5G, Artificial Intelligence (AI) healthcare advisors due to the National Health Insurance (NHI) Bill, and 'data for good' for social interventions. The inaugural Sustainable Infrastructure Development Symposium,

South Africa (SIDSSA), was launched in June 2020 as part of a major government initiative and has encouraged the pursuit of smart cities and the energy-water nexus (including a R12.4 billion investment in Mokolo Crocodile Water Augmentation Project (Phase 2A) at Lephalale region). If ICT is moving in this direction, how does citizen science practise ICT: are water quality management skills preparing the volunteers, for example, with using heatmaps, geotagging and GPS? This introduces the issue of sustain-agility.

The data collected through the citizen science tools enhanced the enviro-champs to acquire a quality reporting system, built confidence within the enviro-champs and reinforced the ability intentionally of the enviro-champs to make service delivery easier for the government, particularly the municipality and DWS. Again, it is **not the data alone but the people and their interpretation of it and their activities that produced data that influenced** government officials to respond and make necessary changes.

The power of the uptake and use of the tools in influencing change did not reside entirely in the uptake and use of the tools or citizen science practice itself but also in the people's interpretation, including linkages to their context, implementation and response to them. This is why one of the participants mentioned that

For the project to be sustainable, we need to get people's buy-in. It is better if it is initiated by them rather than you going to the community and saying that we invite you to start a project. So that they have a sense of ownership and will sustain the project. (T. Luvuno, personal communication, February 12, 2016)

This was substantiated by Thandanani who said "If you can take the enviro-champs away from the project, then the tasks required for the project cannot happen [the people are central to making it work]." (T. Luvuno, personal communication, February 12, 2016).

Programmes on their own could not work; they needed the people for interpretation and implementation. The enviro-champs programme has demonstrated that human agency influenced the change in their socio-ecological system, and in turn, the same system has influenced their lives. As Bandura (2006) put it, "people are contributors to their life circumstances, not just products of them" (p. 164). As such, this study suggests that human agency cannot be separated from the social causations/ mechanisms in the Pawson and Tilley (1997) realist evaluation formula $C + M = O$, following Porter's (2015b) formula: Contextual Mechanisms + Programme Mechanisms + Agency =

Outcome (CM + PM+A=O) and including the Mechanisms = Resource + Reasoning (Dalkin et al., 2015). Therefore the formula this study is based on and continues to address is C (Resource + Reasoning) + P (Resource + Reasoning) + A (Individual and /or Collective Agency) = Outcome (refer to Table 2.1. in Chapter 2).

9.2.6. Discussion Issue 6: The setting of political structures and cultures in and of the Mpophomeni community concerning a citizen science practice

Volunteerism linked to the uptake and use of the citizen science tools of this study may have looked or sounded apolitical (refer to the contextual mechanisms that Liz Taylor used for mobilising the enviro-champs and issue 11 – the declaration statement that the enviro-champs had to announce every time they interacted with the communities). However, unavoidably the data demonstrated a rootedness within politics. Firstly, the programme itself was an extension of the government initiative, MSEP or became a subsidiary programme of MSEP. Secondly, the programme's objective was to drive environmental activism, as Liz mentioned in her early days of conceiving the programme: "Mpophomeni was a vibrant place with many ['activism'] clubs, churches, etc. There were always people who stood up for a course in each of those organisations. Those people were community champions." For an effective and functional government and public services, Liz mentioned the need for "the pressure a bit from local people – need to put some pressure on the councillors" (E. Taylor, personal communication, February 9, 2016) (also refer to issue 7).

Politics being at the fore of voluntary work in Mpophomeni was not surprising because of how the area was historically formed and continues to function. This is evident in statements like, in Kwa-Zulu Natal, particularly in Mpophomeni, "you can't do anything without going to the war rooms"⁶⁸ (T. Luvuno, personal communication, February 12, 2016).

In a citizen science programme of this nature, community services in uMngeni Municipality were the most significant contributor to formal employment, followed by agriculture (uMngeni Municipality, 2018/2019). It was essential to consider preconditioning mechanisms that can either enable or disable the programme.

While politics are part of the change needed in this programme, it was crucial to review the role that volunteerism of the enviro-champs in this community played in the political environment of the

⁶⁸ A war room is a room or space in politics designed for holding meetings for local communities to participate and engage with the government. It is used to discuss activities that need strengthening from the government, to gather information, ideas, plan strategies, direct activities, etc. and guide activities for political campaigns.

programme. Also important was to assess the kinds of state-citizen relationships needed to enhance public service delivery. For sustainable water quality management. From the data (issue 6), it was clear that the development of **trust** was central to all the activities – trust as a personal/collective and political quality (Berman, 2004) or resource, which in this case provided a socio-cultural and political environment that the enviro-champs and stakeholders relied on, for the programme to be what it was and do what it did. In the following section, I intend to elaborate on how trust played a key role in the politics of the uptake and use of the citizen science tools programme.

Trust

Dunn (2000) argued that

Trust is both a human passion and a modality of human action: a more or less consciously chosen policy for handling the freedom of other human agents or agencies... as a modality of action. It is essentially concerned with coping with uncertainty over time... From a holist view, these choices may, in the last instance, be made for them by structural features of the economic, political, or social setting of their lives ... however, the claim that trust is central to the understanding of political action needs to be stated with some care ... rather it can be argued that it is a prominent feature in a socialist state. (p. 1)

Thus, in the enviro-champ context, if government as a structure (and if it is for socialism) or governance as a **political agency** wanted to build a just society and climate change resilient society through creating a platform for collective ownership/agency, it needed and still needs to develop **rational trust** with its citizens (and vice versa) – rational trust that is built on transparency, corruption-free, inclusive political participation, accountable and effective execution. Similarly, the enviro-champs needed to construct this rational trust between themselves and the Mpophomeni community for the citizen science project to succeed. Hence, volunteering can be regarded as apolitical even though it can be a form of political activism for justice in itself. Through the volunteering of the enviro-champs, this political agency was activated.

9.2.7. Discussion Issue 7: Explaining the involvement of the NGOs as project developers in the citizen science project

This section considers the general history of the context in which the programme is situated. By this, I intend to show how that context has preliminary hidden structural mechanisms that can either enable or constrain the uptake and use of the citizen science tools for 'just' sustainable water quality management. This history of context requires deep self-reflection for a meaningful direction going forward. It challenges the judgement that 'programmes are the same regardless of where they are

coming from'. African countries are unique contexts as is South Africa because of its history of the impact of colonisation and apartheid. To name a few, historical plights have influenced education, social development and justice, environmental justice (via activism), international financial aid via NGOs and the history of how NGOs run public or citizen programmes.

Looking deeply into a citizen science programme, this study wishes to explore two premises that form the basis for preliminary mechanisms for the uptake and use of the citizen science tools. One constitutes implementation theory and the other programme theory (Weiss, 1997). Both theories expose the extent to which freedom/ free will and determinism/indeterminism can allow freedom of agency/ action expressed or be exercised by the agents and the implications thereof, specifically for the just sustainable uptake and use of citizen science tools. For freedom of action or agency and justice, free will and determinism are the elements embedded in the concept of volunteerism, which is foregrounded in the citizen science practice.

Both discussions will be based on experiences noted by Liz Taylor from DUCT. Liz discovered early on that Mpophomeni had many people involved in many different community activities in the Mpophomeni area. Mpophomeni was a vibrant place with many 'activism' clubs, churches, etc. In each of those organisations, there were always people who stood up for a cause, and those people were community champions. She therefore found it relatively easy to select enviro-champs from Mpophomeni. For effective and functional government and public services, Liz mentioned that it needed "the pressure a bit from local people – need to put some pressure on the councillors" (E. Taylor, personal communication, February 9, 2016).

According to Liz, she observed a long history of Mpophomeni citizens being involved voluntarily in activities that supposedly create meaningful social change in their lives. Instead of a long history of government doing things with the intention to develop the citizens, there has been a mismatch of values, or rather, there seems to be a growing gap between the two structures such that they seem to be bypassing each other. As an observer and through her agency and an NGO lens, Liz identified the gap and wanted to fill it with the citizen science programme, having belonged to an NGO rooted in a discourse with a long history of social development functioning and education in South Africa, particularly Mpophomeni (refer to the context of the Mpophomeni community and its relation with NGOs in Chapter 7). This context needed to be explored and this section intended to evaluate this in-depth and critically regarding the uptake and use of citizen science tools in the Mpophomeni community by the enviro-champs. The critical lens is needed should the NGO be considered the only

means for enabling the uptake and use of citizen science tools for just sustainable water quality management.

Why look into this section from the NGO point of view rather than simply from Liz's perspective? I argue that Liz or Liz's agency alone might have identified the niche, but acting to close that gap was outside of her control. She might have guided the processes, of course. However, the resources needed, such as funding for the project, were not from her. Also, she was not entirely in control of what had to be implemented and reported and how. However, there is no doubt that Liz personally played a significant catalytic role at the grassroots level and in the programme's operations.

The first contention was based on implementation theory, which states that "putting the intended activities into operation and ensuring that those activities bring about the desired effect" (Weiss, 1998., p. 41). This theory has controlled variables free from or determining the agent's will and agency that constitute two motivational and valuational systems of both the individual members of the programme developers and the agent. The implementation premises are that certain actions are considered of value, and others are not or are indifferent. As such, where divergence occurs, there could be conflicts of interest or causes constraining or enabling the uptake and use of citizen science tools.

Firstly, the section deals with the view that the programme – the introduction of the uptake and use of citizen science tools – was invented by the programme developers as the institutional structure (structural mechanism – resource) for responding to poor water quality management. To take such a brave stance could be detrimental ethically to this study from the project developers' point of view. However, this study does not intend to condemn, as it continues to reiterate, but to allow realist reflections for every stakeholder involved. This view works together with this expression by Thandanani Luvuno who mentioned that he didn't have a problem (with outsiders doing research in Mpophomeni) But what he noticed over the years was that community members "think that you [researchers] extract information from us but... why is it that researchers don't thank us for our time?" (T. Luvuno, personal communication, February 12, 2016) (also refer to issue 9).

A prolonged extraction of information from the researchers coming into Mpophomeni and the community has not led to benefits. It is also evident from this lens, as noted by Porpora (2013), that realist evaluation should explain any change based on what mechanisms are in place for "any

particular social change will need to be explained by the particular structures, by the particular cultures, and by the particular agents involved" (p. 26).

To mention a 'structure' does not necessarily mean that something was intentionally planned to be in that way, but rather the structuration format was observed in its intended operations (refer to issue 5). Structural mechanisms were in themselves presuming agency/agencies, processes and *praxis* (Freire, 2005) that were assumed to be possible media for mediating the problem. These agency/agencies, processes and praxis in themselves were designed, whether consciously or not, in such a way that they determined the outcome (Archer, 1982) and Weiss (1998) referred to them as the properties of the implementation theory. These structural mechanisms are of the hidden order that has a history in the context of the community of Mpophomeni. These hidden structural mechanisms were acting against the individual agency of the programme's agent, not giving them sufficient free will to exercise, because they are determining their agency. The following is evidence that supports the arguments mentioned above.

These above-mentioned views can be overlooked in the assumption that a programme is a programme regardless of who or where it is coming from. But that is not the case in this study. Hence the issues highlighted in the study have demonstrated that their limitations and successes were based on the 'hidden' governance of the structural organisation and observable action patterns (Archer, 1982) embedded in the NGO as the project developers. For instance, the evidence is in the operationalisation of the programme, involving issues such as 'the manner in which volunteerism of this study occurs', 'stipend for remuneration,' 'lack of funding or having to depend on funding aid to carry the programme,' 'community development through learning or education,' 'apolitical course' etc. As such, a realist evaluation ought to investigate the NGO (processes and practices) as a structural mechanism or resource for enabling or constraining the uptake and use of the citizen science tools. This is crucial to scrutinise as far as sustainability for the programme is concerned, as well as to consider the usability of practices and processes within the NGO structure should the NGO be preferred as the means for structural and action (agency) (Archer, 1982) for carrying out the programme.

With this view, this study does not intend to condemn the decisions made for the practices and processes that the NGO employed. It merely aims to show what practices and processes are benefitting or not for which part of the uptake and use of the citizen science tools. It was important not to be naïve and dismiss the critiques that exist in the discourse of NGOs about whether they are capable of enabling or not to carry through the socio-ecological change as they purport to be doing.

Robust critiques can be found in Fowler (1991), Anderson (2017), and Matthews (2017). The study is only concerned about the synergy and the collective value that could exist should more programmes of this kind take the direction of NGOs or take the approach of this programme.

Here I consider the practices and processes employed and how they enabled or constrained the uptake and use of the citizen science tools. The expressions were extracted from the data.

The essential expressions here formed the source for reasoning the integration of the uptake and use of the citizen science tools into, noting, the already observed, existing, and dominating political and cultural fabric of the Mpophomeni community. The keywords in this discussion are **integration** (i.e., melding and becoming part of the already dominating culture), **observations** (the act of noticing or perceiving something), and **bias** that informed the intervention. These three expressions were preconceptions made by the NGO or project developers and it is helpful to interrogate this for the NGO's or project developers' critical self-reflection. They are also critical expressions to be scrutinised because in themselves, they have real, hidden deeper meanings and mechanisms that could either enable or constrain the secondary mechanisms (interpreted by the subjects of the project – i.e. enviro-champs) for the effective and sustainable ways of the uptake and use of the citizen science tools (Graham et.al, 2013). And it is for this study to critically engage with these expressions to see how they can be valuable and usable or not for the uptake and use of the citizen science tools in the Mpophomeni.

The NGO's vision

Lacouture et al. (2015) have highlighted crucial points about the different mechanisms involved in interventions. There are in the already existing context and mechanisms in an intervention and these mechanisms can be seen or should be seen as the opportunities the agent(s) choose to explore to bring about change. These interventions' mechanisms are mostly indeterministic. This means it would be difficult to determine the agents' desires, beliefs and values. And the outcomes are usually probabilistic. So far, the themes of the issues in the study deal with the mechanisms (i.e., reasoning, resources, and agency) found in the socio-economic status of the enviro-champs, perceptions, interactions, and relationships that exist between the enviro-champs and communities, and the government agencies and officials.

In this section, I looked at the mechanisms within the intervention. I started by looking at how the vision created preliminary mechanisms that either enabled or constrained the uptake and use of the

citizen science tools. Within the intervention, there are theory-based mechanisms: implementation and programme theories. Weiss (1997) explained that implementation theory focuses on the successes and failures of how a programme is carried out, meaning an evaluation will examine if the programme was conducted as planned and if the desired results were produced. On the other hand, "program theory looks at mechanisms that intervene between the delivery of the program services and the occurrence of outcome of interests. Mechanisms are not necessarily the program activities but rather the response the activities generate" (Weiss, p. 46). As such, within the vision, there are those two views. According to Lacouture et al. (2015) there is what the team wants, what the team says, and what the team does. "As a result, their typology of mechanisms is structured according to the different levels of interpretation and analysis suggested: i.e., targeted causal mechanisms (which are, according to these authors, close to the level of vision), theorized causal mechanisms (discourse) and observed mechanisms (arising out of practice)" (p. 7). The last part, observed mechanisms and emerging mechanisms, are what Weiss (1997) regarded as programme theory. With this in mind, the study unpacked the mechanisms within the NGO plans and implementation processes.

Discussing ***the vision – the target causal mechanism***: from the NGO's or project developers' point of view, Jim Taylor mentioned that the vision or outcome was for the "manifestation of a learning society.... if the people don't learn, they will not grow" (J. Taylor, personal communication, February 10, 2016). In the GroundTruth proposal, the aim of the programme was to develop a public-spirited understanding of water-related issues and risks (Graham et al., 2014).

Within these expressions, there were assumptions about the intervention logic/reasoning. There was a difference between what they were hoping to achieve (project developers' agency), which they hoped would trigger the subjects' agency, i.e. enviro-champs. They assumed that the enviro-champs and the community would firstly have a desire to learn and extend this to learning together about water-related issues and risks. The two visions were based on a motivational system. Whether that was of value is contested. Specifically, the first part of the question of the realist evaluation inquires about the value in 'what works for who?' – taking into account those who are affected by the intervention (Porter, 2015a; Porter, 2015b).

There is another assumption – a theoretical causal mechanism(s) will trigger action toward the manifestation of learning that is collective hence 'public-spirited' that will somewhat help them grow (as a society or as individuals). Grow in what way? In understanding water issues? To what extent? After all, the question is about social learning occurring within informal institutional structural

parameters and social learning that ought to happen freely. These were critical questions for the project developers to consider when working with diverse groups, particularly this group. Within the vision, there were theoretical mechanisms based on observations (that are mechanisms) proposed before the study. Also, there was a need to be informed by the already existing socio-cultural activities and values in the community.

As already mentioned, **there was a need for an in-depth investigation of the informal community-based volunteerism outside of structures and formal community-based volunteerism within structures to strengthen and align the project's vision.**

If volunteering was the key to making citizen science practice possible, there was the need to look at mechanisms involved in formalising or informalising it. Liz Taylor made vital observations about people of Mpophomeni being voluntarily engaged in many community aspects. She described Mpophomeni as a vibrant place with many 'activism' clubs, etc. She further explained that its community would always stand up for a cause. Understanding such background nuances was necessary because, as a project developer, observing such activities and starting to formalise them by capitalising on mobilising the volunteers for their own developmental activities might change the fabric and essence of that value (Graham et al., 2013). Therefore, it was necessary to investigate such observations further and ensure that project's volunteering integrated into the already social' volunteering approaches is aligned and empowering – rather than disempowering.

Liz Taylor's observations and views were necessary to broaden the social volunteerism within the Mpophomeni community. She mentioned that to have an effective and functional government and public services, "the pressure a bit from local people – need to put some pressure on the councillors" was needed. She pointed out the missing link, the relationship between the people's livelihood and public service delivery (L. Taylor, personal communication, February 9, 2016). At the same time, observations from Thandanani Luvuno brought the element of knowing the government officials, specifically their names and positions, which are considered candidate mechanisms (i.e., mechanisms empirically collected during the study) (Lacouture et al., 2015). As mechanisms evolve with the project and mode of participation, the two observations inevitably change the form of volunteerism, making it more formal – the evidence being that the enviro-champs could attend formal training that was accredited. As a result, this demonstrated that **formal and informal volunteerism could work** only when in-depth interrogation of the vision is applied between what the team wants, what the team says and what the team does (ibid.).

9.2.8. Discussion Issue 8: The second cycle of the citizen science project

This phase of the project demonstrated that the community of Mpophomeni and the enviro-champs truly possessed the innate willingness and capacity to freely help others and their surroundings, a motivation and values with features of ubuntu. They work with ubuntu for the reason of social cohesion. A motivation and values not necessarily associated with any cause, such as religion, politics, fashionable movement, activism, or charity work, would sometimes be universalised, like in the United Nations: Volunteerism (2011). But a more profound cause that centres itself on the desire for a real, meaningful, reproductive social change is situated. As Thandanani Luvuno mentioned "The problem is that these [community groups that exist in Mpophomeni] groups work in silos. Authorities [those who run them] do not want to work together. They want to keep the identity of different projects". A sense of ubuntu within and social development does not fit with this individual competitiveness; instead, they thrive in coaction or collaborative action. For them, the project went beyond water quality management:

They realised through the learning experiences about the project they discovered that the environmental issues specifically water issues and social issues are interlinked... Developing collective agency by working together with other projects was key to ensuring meaningful impact to the Mpophomeni community. (T. Luvuno, personal communication, February 12, 2016)

These kinds of 'volunteerism' and values have survived many testing times or crises (refer to the cultural history of Mpophomeni community) and continue to manifest themselves in relational agency and multi-agency. It is this "fluidity of relationships that do not encourage dependency (e.g. a cause could be of politics or activism) but instead encourages the capacity to both seek and give help when engaging with the world ... as well as adjusting what one does to other people's strength and needs" (Edwards, 2007, p. 1) – but is not limited to being in a professional sense but also to simply being in the world. This is a cultural feature that Liz Taylor was meticulous about, and which the enviro-champs themselves affirmed. They mentioned that these kinds of values and volunteerism are not unique to only the Mpophomeni community but also can be found in other neighbouring communities even if the issues they tackled were different.

This is the kind of interconnectedness between volunteerism and values that exists within ubuntu. This is a tacit indicator demonstrating that "ubuntu is not a nostalgic belief of the past, but rather a thriving mechanism used as a backbone by resilient societies against modernization", as Mbiti (1969) put it. He argued that African people may express this interconnectedness particularly during a crisis.

However, finding examples of this may not be easy because it is sometimes expressed or performed in secret or tacitly.

Evidence of this interconnection was observed in how the enviro-champs 'volunteered' for almost four years, from 2011 to 2015, without any stable remuneration despite their disadvantaged socio-economic background and despite the issues dealt with earlier (refer to issues 1-7). Even though the 'ultimate' goal was to explore and encourage good practices for collective water quality management, it took them a while to achieve this. At this point, practices for water quality management through citizen science tools were not yet well explored. What was clear was that, for the citizen science tools to be taken up, there was a need to 'sort out other things and put systems in place first', i.e. linking other ideas and projects and aligning them with theirs. So this point showed that the integration of the uptake and use of the citizen science tools was not simply a matter of 'plugging into' the project, but instead required establishing and laying down foundational/preliminary mechanisms that would enable the project to take place in a more meaningful manner. It included explaining the NGO's aims in a more justifiable way to the community first, and afterwards, establishing or negotiating values within the project that directly benefitted them. For example, the enviro-champs who had children were empowered (through the knowledge attained in the project) and gained the confidence to help their children with homework, i.e. this was beneficial to them.

After three years in the project, the volunteerism was on a full-time basis, and enviro-champs would work for 22 days and get paid R102.00 per day. Also, the number increased from 10 to 20 enviro-champs. This phase of the project played a vital role in the realist evaluation. It added an element of preparation for the intervention that constitutes preparatory mechanisms or enabling conditions that can ultimately enable or constrain the intervention outcome. The intervention in this case was the uptake and use of citizen science tools.

9.2.9. Discussion Issue 9: The research ethics for researching citizen science projects in a community setting like the Mpophomeni community

This section starts with exploring the following extract from Thandanani Luvuno:

[Community members] think that you [researchers] extract information from us but... why is it that researchers don't thank us for our time? Researchers need to be careful and treat people with respect. Particularly, they need to acknowledge that people are busy [occupied and engaged in things concerning their livelihoods], and they need to understand that if their

interviews are longer, more than 15 minutes, then they need to reimburse [compensate for their time]. (T. Luvuno, personal communication, February 12, 2016)

These expressions show how what can seem to be the logic of applying institutional research ethics in community research can sometimes dissociate from the participating community's social or religious (i.e. ubuntu) ethics (Mbiti, 1969) in communities such as that of Mpophomeni, resulting in despondent reasoning and actions. This despondency can play a crucial role in rejecting the project despite its good intentions.

The consideration and integration of these ethics are essential for explaining that the implications for respect and values honoured by institutional research ethics can be indifferent to those of the participating community. It discerns that it is not only about how one knows what one ought to do (e.g. institutional research ethics) but why one should do what one ought (e.g. social and ubuntu ethics). As Metz and Gaie (2010) argued, to be considerate and respectful (ethical) in the 'Afro-communitarianism' approach is about living harmoniously with others or honouring (what makes) communal relationships. Specifically, educational and social research needs to consider and apply decolonising and transformative discourses in contemporary South African human or community studies. In particular, there is "an understanding of the contribution of volunteerism to poverty reduction as a growing subject of interest in academic and policy fields" (Lewis, 2015, p. 69). The understanding is that being a researcher cannot be dissociated from or be unrelational to the community of study. But it is important to be considerate that the community of study has agency, values and ethics. Thus, a researcher ought to have a communal responsibility and role to play where self-centredness is exempted, meaning a researcher should be "entering more and more deeply into a community with others" (Shutte, 2001, in Metz & Gaie, 2010, p. 30). 'A person is a person through other persons' implies a person cannot only have a commitment to be extractive but also has to have a commitment to give back. Both commitments must be negotiated. Only being extractive is considered self-centred, exploitive and non-ethical, as well as inhuman '*go tlhoka botho*'. Researchers need to embrace ubuntu, which is part of the architecture of most Sub-Saharan communities, South Africans included, including the Mpophomeni community. They ought to demonstrate commitment to treating the community with justice and fairness and show group solidarity, compassion, respect and human dignity (Letseka, 2012). Hence Thandanani pleaded in the above extract that to be a genuine researcher, one ought to have genuine motivation for applying ethics that seek to find a balance between self-interest, and knowing and doing what is good for the community that one works with. Thandanani continued,

Research needs to contribute to everybody's understanding, rather than just being extractive. [For instance, they must contribute to our local economy by booking accommodation at], pay to stay in the Mpophomeni tourism experiences. (T. Luvuno, personal communication, February 12, 2016)

How researchers carry out their studies needs to encompass facets that complete the livelihood of the communities they are working with. Also, researchers need to become part of the community. They could extend their appreciation and gratitude to the communities for allowing them to work with them by staying in local accommodation during their studies. Mbiti (1969) argued that to have a complete understanding and to learn about the African communities, cannot happen only through observations but by becoming part of them. This allows diffusion of power in knowledge production and reproduction. Also, it demonstrates that not only are they concerned about a matter of knowledge production but also are becoming contributors to the local economy that matters to the community. In Thandanani's view, the latter was a reflection of fairness and (social) justice for both research and the community.

Thandanani mentioned that **funding** is key for taking the work like that of the enviro-champs forward. If there is no funding, people would only volunteer for a short period. As such, volunteering is not going to be sustainable.

This highlights another fundamental factor in citizen science practice that Thandanani was concerned about – the sustainability of the programme based on volunteerism – considering the background of the community in Mpophomeni. He was implying that **non-payable volunteerism** is only a 'short-term fixer'. To sustain the programme, **employee volunteerism**⁶⁹ must be recognised and implemented. Here Thandanani explained that it is not enough for researchers to set up conditions for research that only directly benefit and protect them, their institutions and studies without considering the socio-economic background of the community of study. It is also not fair to only set up conditions that will only benefit the community for a short period considering the potential lifetime benefit to the researcher.

Mechanisms (such as the provision of project T-shirts, food, and going out for excursions) may have seemed mere material resources. However, for the enviro-champs there was deeper meaning and these aspects were experienced as more emotional and spiritual (e.g. hope, enlightenment, relief) resources and kept them going. Thandanani Luvuno noted he would not have afforded excursions,

⁶⁹ Employee volunteering entails the schedule, expectations, strategic planning, intentions of the practice, dedicated time, knowledge and skills acquired (Graham et al., 2013)

e.g. Drakensberg mountains, if DUCT had not taken them there. Also, notably through these excursions, he was able to see life differently. For them, these were symbolic gestures of recognition, appreciation, and respect.

The enviro-champs later reached out to the community's needs outside the project's needs (e.g. petitions linked to other unsatisfying public service delivery). These extended activities, to some extent, were subtly challenging (and expanding) the project funding model and subtly transformed the programme implementation model. This shift enabled the project to stand out and have more profound and meaningful value to the enviro-champs and the community. One of the examples is how Thandanani branched out to do street theatre drama on his own, as well as how the enviro-champs owned the kids' clubs and kids' excursions. At the same time, the consequence of these emergent activities was putting the project's intent and management at risk – making its guiding principles, boundaries and responsibilities blurry. As a realist evaluator and project developer, these shifts and boundaries needed to be negotiated as the projects progressed specifically for ethical considerations. It might not always emerge in all community studies, but **reservation mechanisms** should be put in place as a contingency.

9.2.10. Discussion Issue 10: The municipality ward's point of view in the citizen science project

The ward councillor mentioned that

For change to happen in Mpophomeni to a better township, we need to work together and communicate. Identify all those things that are bringing down our community. And we need to have a mechanism (s) for dealing with all these things. ...The municipality had their own programmes, and the enviro-champs had their programmes. As the municipality, they consolidated both programmes to make it one even though the enviro-champs are the ones who did great [more] work. (Councillor, personal communication, February 17, 2016)

Here the councillor identified the need to find a relational agency between the community of Mpophomeni and the municipality. Edwards (2007) described this as one who sees value and is willing to offer support to the common good for a meaningful full-spectrum impact while recognising the need and value for gaining support from others to enhance one's self development. It resonates with the community agency centred on ubuntu, 'I am because we are' that is based on the understanding that the ability for "one to engage with the world is enhanced by doing so alongside others" (ibid., p. 1). However, as Edwards (2007) argued, it is not about creating dependency but creating a developmental space for people always to want to seek and give help as they navigate the world. Edwards's view is, however, limited to a professional space, where both parties have 'institutionally recognised' professions. Despite a different professional space she was referring to, this view can help

us see that that world can exist, where people can live together with the cognisance that as they build, they earn to be made in return, not the other way round. It is a quality and capacity for building community agency.

Even if community agency can exist in this context, "considerable structural and cultural barriers to effective community agency still exist" (Swanson, 2010, p. 10). There can be a problem of freedom of alternative possibilities if the agency to take action is still within a centralised system. Even if one can end up having more control over the rules on how the activities should happen, actualising them will always be the problem. Consequently, a platform is created where benefits and responsibility are distributed unfairly. As the councillor said, "As the municipality, they consolidated both programmes to make it one even though the enviro-champs are the ones who did great [more] work" (Councillor, personal communication, February 17, 2016).

For the consolidation of citizens and government programmes and approaches to be effective and more impactful, citizen or participants' justice need to be considered. The initial conception of developing the citizen science project for the enviro-champs thus involved the Mpophomeni community generating alternative expressions for challenging local government management mechanisms or systems to improve public service delivery (refer to Liz Taylor on issue 7).

Furthermore, if participation is controlled, it could lead to regression, hindering freedom of action and moral responsibility in participating in conditions the citizen science practice requires or offers. Again if participation is controlled, it cannot be considered an alternative possibility for improved water quality management and would not support the intent of this citizen science practice. At the same time, it can be noted how difficult it was to seclude the citizen science project from politics. However, some political aspects were important and enabled the project to go forward, such as:

- Getting the leadership of the municipality involved,
- Maintaining good communication with the municipality,
- Bringing the municipal officials on board,
- Communicating their projects, explaining their challenges and their needs.

The councillor commended the enviro-champs for these aspects; for the project to be successful in Mpophomeni, it needed to be inclusive of the government and be aligned to the government programmes. In pursuing these aspects, the enviro-champs learnt other skills and competencies outside of the water quality management – though this took them a while (more than two years), as Liz Taylor explained. These included learning political culture: i.e. language, and processes of the local political leadership and learning how to align themselves with their policies or modify the government

processes to suit them strategically. They also learnt communication skills and stakeholder liaison and how to negotiate platforms for their voices to be heard. Moreover, they learned ways to make their project's services indispensable and created a demand for their services.

It might not have been the initial intention to develop a localised community agency. Indeed the enviro-champs separately developed different agencies and played different roles contributing to the process and localising the policy. As the councillor noted, "as a councillor, you cannot do everything. You need Liz, and you need these groups [enviro-champs, for example] to help the community because it is part of the service deliver." (Councillor, personal communication, February 17, 2016).

Community agency was developed through learning and understanding factors that inhibited the programme's progress. The case study demonstrated that creating change and establishing an inclusive process where relational and community agencies and interests are foregrounded takes elongated negotiations in political structures and endurance. For the community's interests to be taken seriously and to be sustainable, they required an ongoing process of negotiations, where being relevant and tapping into political agency was vital. The councillor's explained that he was aware that most of the councillors were on board initially. For the enviro-champ project to be sustainable, the enviro-champs should continue to ensure that they put them in the loop all the time to continue to be involved. However, this process has to be two-way and be fairly distributed.

9.2.11. Discussion Issue 11: Overall impact and consequences of the outcomes of the citizen science project in Mpophomeni

There is no doubt that water quality management via citizen science practice at Mpophomeni unlocked opportunities beyond those, i.e. socio-ecological development, intended by the project developers or the volunteers. The citizen science project made a difference in the daily lives of the volunteers but was not significant enough to sustain them. It eventually became subsistence for many. It is evident that the principles of volunteering in South Africa and Africa need critical evaluation for socio-ecological development programmes to have a significant and meaningful impact on the lives of the volunteers (Graham et al., 2013). Volunteers need to be empowered to make democratic public participation possible.

Citizen science practice of this nature has demonstrated a need for great attention to balancing gains from volunteerism for socio-ecological development, political development and economic development. It was evident that socio-ecological development programmes alone cannot develop the community and the enviro-champs. There was a need for a holistic approach to committing and

investing in citizen science programmes. The forces that needed strengthening were those internal and external to the programme. A few are highlighted below.

Internal forces

- The 'Liz force': Liz Taylor's genuine observations and being a **catalyst and at the frontline** to create a just change was an **anchor** to the programme.
- The 'Thandanani force' supported an **in-depth understanding** of the Mpophomeni community, relationships and politics.
- **ICT skills** were critical, not only for the programme but also for the volunteers to see themselves participating in technology and intervention and understand its significance in their lives.
- The **role of aesthetic** and appreciation of natural beauty through excursions and walking along the streams had mitigated what Pullman (2002) termed 'basic'⁷⁰ and 'personal'⁷¹ **dignity**. It is in the real domain (Bhaskar, 1979), whereby one is morally obliged and has a moral duty to relieve pain and suffering of others. Liz Taylor and DUCT might not have been aware of its impact on the volunteers, but the effect was life-changing. This was used as the mechanism to see life differently despite the suffering surrounding the volunteers and the community of Mpophomeni (T. Luvuno, personal communication, February 12, 2016).
- To achieve a learning society is a continuous process and requires **patience, kindness and empathy** as illustrated by the example of addressing illegal dumping :

The other day, I asked this other person not to do illegal dumping because the municipal truck would collect them, but she went ahead anyway. I took a photo and then told Baba Cele. He went to talk to her, and she was very sorry. (T. Luvuno, personal communication, February 12, 2016).

External forces

- The war rooms created a safe and functional engaging space for the volunteers to make their contributions known and indispensable.

⁷⁰ Basic dignity – the 'inherent dignity' of every human person irrespective of rank, station, or any other contingent quality (Pullman, 2002)

⁷¹ Personal dignity – "dignity that is particular, individualistic, and transient in nature. This is the dignity that is tied to personal goals and social circumstances, to a sense of who one is as an individual in the social world. It can be either enhanced or diminished depending upon a variety of circumstances. It can be affected by events outside the control of the persons involved" (Pullman, 2002, p. 76).

- The door-to-door campaigns provided a platform for one-on-one interaction and deepened a level of understanding of the problem. Furthermore, they helped with building and earning trust and creating demand.
- The collaborations and relationships with other community activities and activists.

It is important to strengthen the above-mentioned aspects for citizen science projects specifically in terms of the volunteering approach. Citizen science projects can then produce substantial and sustainable socio-ecological, economic and political development outcomes for improving the lives of volunteers. The study by Graham et al. (2013) demonstrated that volunteering work plays a critical role in governance. For instance, in 2004, SA's percentage of GDP, civil society activities accounted for \$1.7 billion or 1.3 % of GDP. Thus the volunteering industry employs thousands of volunteers, and considering the unemployment status in South Africa and Africa, this volunteering industry has a huge potential to relieve unemployment.

9.3. Summary of Chapter 9

The section has discussed central mechanisms playing pivotal roles in citizen science projects for water quality management in poor communities like that of Mpophomeni. The issues that surfaced key mechanisms and the complex CMO configurations discussed above, were divided into five categories: the people as volunteers; the NGO as a resource and means for interceding citizen science project; internal and external forces affecting the citizen science practice; research ethics as both a principle for evaluating and conducting citizen science practice; and the impact and difference between informal and formal volunteerism.

In terms of the people as volunteers, their interpretation and activities served as a social and economic resource for the practice. Collective and individual agency are valuable in practice. However, to sustain them, one must understand the formal and informal participation or volunteerism needed.

Informal volunteerism entailed altruistic reciprocity driven by free will, trust and the spirit of solidarity when on a small scale. As soon as one expands or scales up the practice, one needs to formalise and strategise participation by putting in place capacity building processes and financial resources. The more formal the practice becomes, the more inclusive and fair it will be.

NGOs served as a structural resource. Their intentions and implementation strategies were vehicles that needed evaluation to ensure the socio-ecological development of the practice was fulfilled.

Internal and external forces included political structures and cultures needed by the citizen science practice to catalyse political agency and rational trust. Lastly, the external forces had preconditioning mechanisms such as building and earning trust from the community.

CHAPTER 10

SYNTHESIS OF THE STUDY, CONCLUSIONS AND RECOMMENDATIONS

10.1. Introduction

This thesis was constituted as a realist evaluation inquiry and used **the realist evaluation question 'what works for whom, under what circumstances and why'** by Pawson and Tilley (1997) to help explore the initial research done with GroundTruth (see Chapter 1), focussing on the following aspects (see Chapter 1):

1. Who was involved in the uptake and use of the citizen science tools and why? (e.g. value, interest and benefit) at the time of the introduction of tools, during the use, and continued to be involved. Who should be involved for change/improvement to happen? And what were the relations between them?
2. What citizen science tools were available, and which were regarded as 'generalisations' for application into diverse contexts? And why?
3. What were generative mechanisms used by the citizens in the uptake and use of the citizen science tools to reach what outcomes? Mechanisms which can be 'retroduced' (their existence are inferred), 'intransitive' (they exist whether or not they are detected) and 'transfactual' (they are enduring not transitory) (Scambler, 2012).
4. And how did the context influence uptake and use? To what end?
5. How did the intervention process enable or constrain the uptake and use of citizen science tools for what purpose, for whom, and why? To what end?
6. How has the uptake and use of the citizen science tools enabled or constrained participation and engagement? What form of participation? To what end?

The realist evaluation questions helped assess how the citizen science intervention could be sustainable and transformative by supporting social learning and public participation through its activities in water quality management and its policies. The activities were executed by the youth enviro-champs and the primary school teachers as the two key agents that can bring significant change into the discourse. This study then emphasised why a careful and intentional public participation process and consideration for water quality (and quantity) issues in communities, at a local scale, must be taken seriously in the state's developmental agenda. In both cases the importance of aligning the

citizen science practices and the use of CS tools and approaches need to be carefully contextually situated and aligned with local cultures, structures and the personal interests and of those involved.

In the context of the Vaal-Triangle teachers, a key insight was the importance of alignment of CS approaches with the structural processes and cultures of the schooling system which ranged from curriculum alignment to quality management structures and school governing structures and processes (cf. Chapter 6).

In the case of Mpophomeni, the study showed that if the enviro-champs are positively supported through different innovations and approaches (including training, as well as employment and other mechanisms), they can help improve their health and rivers, governance politics, social development, dignity, ecological integrity and economic status, and the community if the interventions were sensitive to local cultures and contexts. For example, Midmar Dam was free from contamination, the river was clean, and the enviro champs felt proud of their achievements and contributions to this situation. They felt useful in their community (see Chapter 8). With further support, Ayanda Lepheana found decent employment, and Thandanani Luvuno managed to make extra money from street theatre (see Chapters 8 and 9). Furthermore, as a result of this study and other citizen science studies in the CBWQM project (refer to Chapter 1), more than 300 youths enrolled on a better one-year payable volunteering project via the Amanzi Ethu Nobuntu project in 2021 (Lotz-Sisitka et al., 2022).

This study illustrated how different stakeholders, structures, cultures, and agencies relate as mechanisms (i.e. resource and reasoning – in the real, actual and empirical) and **interacted** at different levels, scales, time, space, and history. It considered how they affected the uptake and use of citizen science tools (see Chapters 6, 8 and 9). It further demonstrated how the studied mechanisms in this study, together with the citizen science workshops I was involved in (refer to Chapters 1 and 4) and the CBWQM project, could influence the overall systemic citizen science intervention in terms of efficacy, agility and sustainability in the water quality management of South Africa. The study conducted a detailed evaluation of public primary schools and the Mpophomeni township community via the Vaal-Triangle teachers and enviro-champs (Chapters 5-9), and despite their small scale, they **provided a broader and more in-depth critical, reflective and transformative view on the relationship between context, mechanisms and outcomes for thinking and practical learning to approach citizen science practice in general.**

As explained earlier, the study focused on evaluating the application of the CS interventions and aspirations as applicable to different contexts and considered how the uptake and use of CS tools helped achieve social learning and democratic public participation (or not). Social learning and public

participation in these contexts were shown to be not simply an event, but instead, they evolved as complex processes in various ways (i.e. in terms of time, scale, history and space) and demanded different methodological approaches to unpack the layers and nuances embedded in these processes (see Chapter 4). The analysis and development of an understanding of these layers and nuances **illustrated new perspectives that provided novel opportunities** to elaborate on the broader and in-depth aspects of the core question posed by Pawson and Tilley (1997) as part of citizen science practices in water quality management in South Africa (see Chapters 6, 8 and 9) and perhaps globally where poverty is endemic. Through these new perspectives, this study contributes novel approaches to citizen science practice, realist evaluation theory and its methodological operationalisation as part of water quality management and broader social and environmental education qualitative research.

Furthermore, in a study like mine, where public participation in social science, environmental education and policy meet (point A in Figure 1.2), despite deconstructing two different cases separately (i.e. the Mpophomeni enviro-champs and Vaal-Triangle primary school teachers), it was impossible to **define the context** of the uptake and use of the citizen science intervention (s) as universal or general in all cases (Greenhalgh & Manzano, 2021) (see Chapter 2, Table 2.1; hence Chapters 5 and 7 were written separately). Even within the same case study (for example, the Mpophomeni enviro-champs), it was impossible to generalise the context because of the different stakeholders and participants involved, their diverse backgrounds/histories, intents and purposes, how the project was conceptualised, the interactions involved, etc. (see Chapter 8; Chapter 4, section 4.5.1.1. CMO configuration – a methodological approach for evaluating and analysing interviews). Moreover, through these different backgrounds, the study revealed that **context**, defined in a realist evaluation theory, can only be understood in relation to emerging practice to appreciate it fully. Thus, working with the combinations of in-depth elaborations of context (s) and how they, relationally, triggered mechanisms of the intervention(s) was a significant contribution to realist evaluation theory and citizen science practice.

From here onwards, I divided sections into parts related to how the thesis chapters connected. Hence, the following sub-sections are drawn together from the previous chapters and use the findings to illustrate how I addressed the research questions. Each part explains the central claims of the thesis backed up by evidence. At the same time, each section provides recommendations for future studies in citizen science practices, particularly in Africa.

10.2. Part 1: Policy, public participation and volunteerism

In chapter 1 I introduced a heuristic model (Figure 1.2) that helped to conceptualise the focus of interest in this study in the context of policy-science-practice relations (refer to Figure 10.1 also cf.

Bonn et al., 2018). Supported by the empirical data, it was proposed that intersection A made **participatory democracy** possible in practice as illustrated in the case of Mpophomeni where it was shown to be both viable and visible because of how the design and operations of the citizen science project allowed the Mpophomeni enviro-champs to be innovative and creative. The door-to-door technique was the most notable practice that enabled participation (see Chapter 8). In the case of the Vaal Triangle teachers, co-engaged school governance processes was shown to be important. In both cases **agency and motivation** of participants was important to support. The practice furthermore demonstrated that the **type of participants, and thus participation**, as well as **adaptive platforms** (i.e. the DUCT citizen science project model – refer to Chapter 8, issues 3 and 4) and the types of tool used (especially innovations in tools) and alignment with community, curriculum and schooling organizational structures were responsible for connecting natural science with policy and the public, thus enhancing the project's impact. The study also showed **policy benefits**, but also that **policy was inadequately resourced** at implementation level to realise these benefits through CS tools. Lastly, the study illustrated that intersection A is a process in which intentional learning was endorsed, where **patience (time), honesty (ubuntu)** and **'the commoning'** were virtues (see Chapter 8 – Liz Taylor's (NGO) accounts). It was interesting to discover this uncharted space – where the tensions between the 'data' science (the responsibility of science to society), the public (the personal interest of people) and public policies (regulating authority and allocation of values) unfold as part of the citizen science project activities. Figure 10.1 summarises some of the key insights from the study related to the intersection A, which are elaborated in the steps outlined below.

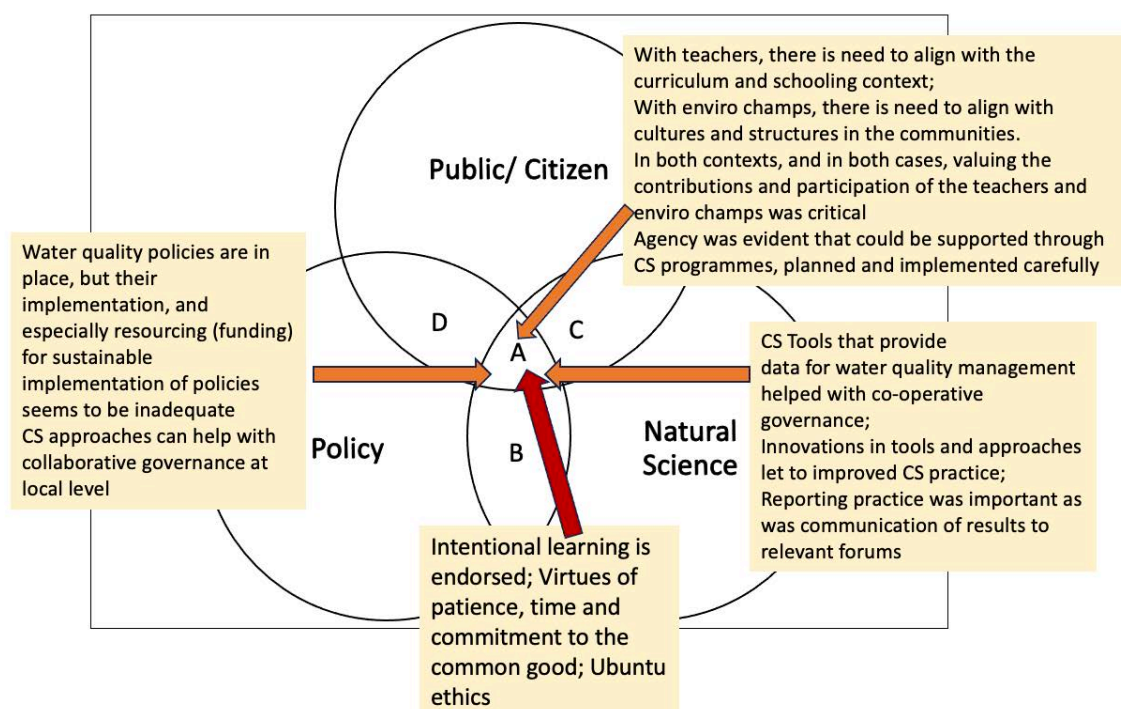


Figure 10.1: Public-Policy-Science interface relations in citizen science (as elaborated via this study)

In this heuristic, an ideal public-science-policy process for CS involvement in water quality monitoring using CS tools is represented by A in which public, science and policy align and are mutually respectful and supportive. A similar model in Bonn et al. (2018) sees citizen science as innovative contribution to advances in science, policy and society.

Firstly, the policy review was initiated at the broader level, looking at a global, international level, continental, and local level policies (see Chapter 1). The policy review aimed to understand public/community participation in water management sciences and how, in practice, it takes form, especially at the grassroots level. The study shows how the commonly known epistemological notion of public participation (e.g. most common Arnstein degrees of citizen power⁷²) differs from its ontological enactment, especially in the context of citizen science practice, where it happens on a volunteering basis. Understanding policy reinforcement processes through public participation in the context of Mpophomeni settings differed from the Vaal-Triangle school teachers; one was fluid and the other structured, indicating the different ontological enactments and their influence on the uptake and use of CS tools and thus also public participation. The study then further claimed that in the Mpophomeni case, the entry point of understanding public participation first needed to reconcile the tension between the **expected volunteerism** (from a science-policy interface – DUCT NGO) and the **lived experience volunteerism** (from the public – Mpophomeni enviro-champs). Two notions were elaborated in-depth by ubuntu ethics (see Chapter 3 and Chapter 9), i.e., expected volunteerism was based on transactional intent, whereas experienced volunteerism on relational intent will be explained and summarised later.

10.3. Part 2: Policy review and public participation

Three issues emerged strongly in the policy review: first, there was a need for **clarity of who the public is, their interests and what they represent in public participation** and it was important not to conflate them with who the scientists were, their interests and their role. The implications of such decisions needed to be considered. Drawing on Ayanda Lepheana's background (the unemployed youth at the beginning of the project and member of the Mpophomeni community), interests and role as a public, and Jim Taylor's background (the scientist), interests and role as a public, I thus differentiated who the public and the scientists were. This background is critical to identify whose needs, intents and agency are served in public participation, explicitly addressing the notion of fair inclusivity in public participation. Furthermore, it is fundamental to further elaborate on the difference between Ayanda and Thandanani 's backgrounds with reference to the public and youth (refer to Chapter 8) so as to

⁷² Degrees of citizen power is inclusive of citizen control, delegated power and partnerships (Arnstein, 1969).

not conflate them. Lastly, the public school teachers are the public, but their agency and intents differ (see Chapter 6). Hence, understanding the social view (as a transformative tool) of public participation offers a deeper understanding of what the ontological enactment of democratic participation in policy implementation looks like (Lotz-Sisitka et al., 2018; Wilson & Pereira, 2012).

Secondly, the policy review indicated a need for **clear translations and interpretations of processes of policy intent into action** (Lotz-Sisitka et al., 2022). This goes hand-in-hand with who is strategically put at the policymaking table to influence change and make those translations practical. In Chapter 1, I gave an example of how the late Kofi Annan, a Ghanaian, influenced water policy in the United Nations to fit the African context (refer to Chapter 1). Though working with the **public is at the centre of this translation process** (ibid.), the study illustrated that the problem of influencing change in public participation is systemic (refer to Chapters 6, 8 and 9). Hence it considered **how the public being politically and epistemologically represented is critical** in fairly distributing power in the public participation process. For example, it is critical to explore how roles and representations of individuals (such as Thandanani Luvuno), NGOs, WRC, and the CBWQM scaling research team (Lotz-Sisitka et al., 2022) are distributed in a project. By analytically differentiating them, the word 'public' becomes inclusive. As a result, the knowledge co-creation and public policymaking processes that serve all can be acknowledged rather than relying on one party to develop public policy and knowledge as a replication of the other/ that which privileges others. The study claims that putting the public as part of the decision-making process and fairly representing their interests and knowledge is an example of what governing with the people looks like for the common good (example of the Mpophomeni case) – for instance, providing decent employment (in the case of Mpophomeni youth) or incentives (in the case of teachers) whilst they monitor and manage water quality for the common good. Though the latter is fundamental, to demonstrate the commitment to the cause, the study's data illustrated that **legitimation and procurement of funding** (e.g. ceasing of the stipend in the Mpophomeni case affected the project progress negatively) are needed for the public to succeed in this platform (Lotz-Sisitka et al., 2022).

Lastly, the Mpophomeni context illustrated that what makes participation active and able to affect change is in 'how and where one participates' – for example being involved in the ward meetings (see Chapter 8 and 9). Policies in themselves cannot effect change, but changes lie in **the capacity people develop in governance and strategic activities to manoeuvre participation** (see Chapter 8 and 9). Thus to sustain the uptake and use of citizen science tools and make a transformative impact, **politics of governance (e.g. drawing attention from the government) and cultural politics (e.g. building community trust)** are critical for strengthening participation. By politics here, I do not necessarily

mean affiliation to a political party or being apolitical, but being 'politically-smart, informed and engaged' (Lewis, 2015) to gain buy-in from other decision-makers and guide expected outcomes (see Chapter 8). For example, through the participation of Thandanani Luvuno, a political activist, things started to move and change because of his guidance on how to approach decision-makers and ways to make the community part of the project intent, e.g. via street theatre.

10.4. Part 3: Ubuntu ethics and volunteerism

Following the policy review, I then elaborated on ubuntu ethics, based on ubuntu's foundation in **mutuality** philosophy and cultural experiences promoted by the constitution as an ideal democratic model. Ubuntu was a significant concept for the study because of its intent '*motho ke motho ka batho ba bangwe* [I am because we are]', and how in itself there is ethical thinking that promotes **relational ethics of care**⁷³ and **supports political and social justice** for the common good (refer to Chapter 3). It was the in-depth understanding of this care (and social justice for the common good (i.e. management of water quality) that was a central interest to this study and from which the citizen science intervention emerged. It was presumed that participants in the study inherently possess this sense of care and could express it 'voluntarily' in pursuing the interventions' agenda. Working with ubuntu ethics illustrated its potential to be **an epistemic assessment tool** (Beets & Le Grange, 2005), especially when unearthing and challenging cultural systems and multi-levelled notions of '**voluntary participation**' and social justice in the 'care for the common good' agenda (see Chapters 8 and 9). Ubuntu ethics helped unpack two cultural systems forming the basis for this study's intervention, **the citizen science project cycle aspect** and **the qualitative research methodology aspect** (see Chapter 3, 4 and 8) – adding to the qualitative research (Le Grange, 2018a) (i.e. planning, implementation, analysis, and interpretation) and hydro-sociological and hydro-hegemonic perspectives (see Chapter 1). While the two **provide systemic insights of care/caring** to improve water quality management through citizen science practice, the main focus was on the former.

In context, investigating volunteerism in the citizen science project implementation and intervention stemmed from discovering **the disjuncture of what volunteerism is** between the NGOs' perception and people on the ground. The **tension was at the entry point of understanding volunteerism**. The NGO's account was based on the observations that contained transactional expectations, 'I am doing something for you'. Hence, they thought establishing the project in Mpophomeni would be ideal based on their observations. In this way, their observations within an ubuntu view suggested the NGO as an external subject. Their view came from seeing the individual(s) or community doing things together

⁷³ Relational ethics of care here refers to value systems and actions that are participatory but can include those that are non-participatory, e.g. avoidance.

for what seemed the common good. But this view lacked understanding of the nuances of individuals' interconnectedness, what made them a community, and why they do things together for what common good. The NGO perceived the objects of concern as being of everyone's interest – i.e. improving nature or rather water quality. It only looked into how this collectivism, from the outside, can be leveraged to enhance water quality, but left out the crucial dimension of social relationships. In the school context, this was related to the school-community relationship. This was problematic for the Mpophomeni enviro-champs (community) because, for them, it meant 'we are doing something for us – and in us, I am' – a relational approach taking moral obligation of the other – the ubuntu view. Hence, to understand and apply ubuntu ethics, one cannot separate the relationship between the self, social relations and nature – they are the **ecosophy** (Le Grange, 2020, quoting Felix Gauttari (2001) on the three ecologies), meaning they are inextricably bound up with one another and need to be understood transversally. Therefore, the strength in adding the social dimension into the equation was that building community is as important as the goal or object of interest, i.e. water quality management. In actual fact, **the value and meaning of the intervention's goal emerge from the process of building the community** (see Chapter 6, 8 and 9). As Thandanani Luvuno explained, “without the people, the project and its goals are non-existent” and as the principal explained, there is need to involve the communities and the school governing bodies. The NGOs recognised the value of community, its role as social accountability is part of these change processes. Furthermore, Thandanani noted “we want to see Mpophomeni nice [environmentally appealing] where it used to be, but if I do not do this [bring the change], who will?”. The evidence of enacting ubuntu is illustrated not only through their sayings but also through their doings – for example, through initiating a door-to-door approach to reach out to individuals caring about their issues, volunteering to fix taps in homes, and further sitting down with community members to discuss other concerns such as social grant issues. A further example was ensuring that they invited social development officials to their ward meetings to assist community members with problems, and they also asked the local hardware store to help with resources to fix the taps. In the context of the schools alignment with teachers responsibilities and the curriculum was key.

I consider intersection A represents the liminal space⁷⁴ (borrowed from Eliastam, 2015) of ubuntu as ethics thinking, where understanding its epistemological notion becomes translated into its ontological enactment. To **fully** appreciate it from another society's experience and to build trust, one needs to be fully converted because observations alone are not enough to make complete inferences (Mbiti, 1969). This is because the community's actions are rooted in their beliefs (ibid.), and by

⁷⁴ By liminal space here I refer to ‘an ideal space/bridge but not yet there’.

incorporating their views in the citizen science project, data showed that there must be a willingness, determination and building of capability to take advantage of ubuntu virtues of humanitarian, communitarian and social accountability for the common good. To unpack such intricacies of ubuntu ethics and work carefully with their nuances, I was guided by the writings of Mbiti (1969) to understand what ubuntu is as a religion (i.e. cultural and traditional belief and practice) and the philosophy of Africans. Mbiti (1969) (see Chapter 3) advised how to carefully work with these aspects of ubuntu, providing insights which I then supported with that from Le Grange's (2002) writings about the influence of the education system and its context (e.g. poverty) on environmental education and its implication for implementation. The writings of Le Grange (Beets & Le Grange, 2005; Le Grange, 2012a, b; Le Grange, 2018b) (also see Chapter 3) on ubuntu, especially his conviction for social justice and sensitivity in education, environmental education and entire cosmos discourse was of crucial importance – not only his pro-ubuntu views that were fundamental and supported the study's argument, but also his respect and appreciation of **ubuntu as an (ethical) junction of environment, self and society**. As a result, ubuntu ethics sit very well in intersection A (refer to the model above) because they create a multi-dimensional meeting point:

- the ubuntu ethics philosophy and understanding in the context of citizen science practice allowed the learning of the community better to develop their agency effectively;
- ubuntu ethics made the science open, accessible and usable by including situational and indigenous knowledge and innovative practices;
- ubuntu ethics, by engaging with policy, developed its capacity to be empowering for communities.

Ubuntu ethics became a holding thread for **social and environmental education inquiry in the thesis**, where I looked at the project's social impact or lack thereof for public participation. Firstly, ubuntu helped me be sensitive and careful from the inquiry's onset (refer to Chapter 4, Phase 2: Ethical procedures for interviewing with the participants). I looked at what happens with the uptake and use of the citizen science tool in both contexts. Through gaining access to the study, and the experiences this afforded, I came to understand that I needed to transcend the contemporary ways of requesting access to research with communities, e.g. request for consent, and rather enter into a relational space with them. Hence, I needed ubuntu to help me negotiate the relational space of creating a trust that embodies respect for the humanity of others, tapping into the gesture of '*matseno or go kokota*' (refer to Chapter 4, phase 2). This gesture means 'I come in peace with good intentions of building a relationship with you and must be alert of my future correspondence since I am unknown to you. Also, I intend to come back to you; thus, my future correspondence must not be of a surprise'. It is a non-

material social value that became a mechanism for activating empathy to carry through the thesis writing. It was a quality that, as a qualitative researcher, I was obligated to be aware of (Ghoshal, 2018).

10.5. Part 4: Uptake and use of the citizen science tools and its practice

At the same time, the uptake and use of citizen science tools in practice consisted of the *technical inquiry*, where I evaluated its scientific impact or lack thereof in enabling public participation. For instance, using ICT skills such as smartphones to capture GPS coordinates (refer to Chapter 8 and 9, issue 5) and read mini-SASS scores, uploading them to the heatmap (refer to Chapter 8 and 9, issue 1). The inquiry responded to one of the leading research questions of the thesis 'what citizen science tools were available, and which ones were regarded as 'generalisations' for application into diverse contexts? And why?' (refer to Chapter 1). The issue with the uptake and use of the citizen science tools was a generalised assumption that 'after introducing them, the participants will readily adopt them and apply'. The following were seldom considered as illustrated by the data was the following **circumstances**: firstly, the Mpophomeni community versus the culture and agency of Vaal-Triangle primary schools; secondly, the contextual difference of streams, including depth, spread and relationships; and lastly, the varying scientific capabilities of participants in taking up and using the citizen science tools. As such, background factors practically determined how the citizen science tools enabled or constrained public participation.

Of all the tools introduced, i.e. the water clarity tube, velocity plank, the mini-SASS toolkit, etc. (refer to Chapter 6 and Chapter 8), the most commonly used and preferred in both cases was the mini-SASS. There were many reasons the mini-SASS was chosen over others, but to mention a few, the Vaal-Triangle primary school teachers enjoyed it because it made them and the learners aware of the life that occurs in water bodies and the relationship between river health and human health (refer to Chapter 6). Such relationships were not easily noticeable by virtue of the schools having regular access to clean water from the taps. Furthermore, teacher and learner schools or homes were located a little farther from the Vaal River systems. The introduction and use of mini-SASS and other citizen science techniques were ideal for classroom learning theoretically but almost impossible in practice because, for example, the Vaal River was too deep and far from the schools to perform mini-SASS. Also, there were substantial bureaucratic hurdles, such as a lack of support from the school governing body and parents (see Chapter 6). Most of these stemmed from a **lack of support from the curriculum culture and structure** for the initiative and teachers' agency (see Chapter 6). The public schools are run and driven by the curriculum; without alignment and support, the teachers' agency can only take them so far. Hence, they did not engage with the tools enough to create value beyond immediate value

(Wenger et al., 2011). As a result, the uptake and use of the citizen science tools did not help them develop sufficient participation to make a substantial impact, with the project ultimately ceasing. However, there was potential for citizen science practices to assist in aligning activities to the subjects in the curriculum through participation and making it relevant to achieve quality education (see Chapters 3 and 6). However, for this potential to be activated and to sustain its impact, it was necessary to promote the immediate value into other values (Wenger et al., 2011), which required **the structuring of activities and systems that monitors and evaluates citizen science practice impact within the education system** (see Chapter 6, issues 1 and 3), supported by the following quote from one of the teachers:

If something [outside the syllabus] doesn't get to be monitored or followed up; then the activity doesn't get to be taken seriously, it loses the momentum and the interests fade away with time..... I still have that passion to continue encouraging other educators. Still, there is no follow-up [systems/structures put in place], so I cannot see the end of my efforts. As educators, the water issue required us to sit down and discuss it as a subject of profession and an initiative... I would advise the basic education system to allow a system whereby educators become experts in the subjects because when the workshops like this happen, they will be building on what we already have. The problem is that sometimes educators who attend these workshops don't teach the subjects dealing with the issue. Taking new educators for an ongoing workshop will result in regression because you have to start afresh all the time. And by so doing, you are not building, or there is no development. (see Chapter 6, issue 3e) (Teacher A, personal communication, September 1, 2016).

Hence, this study's insights are suitable for enhancing the relevance and the need to support current programmes such as the programme which advocates a “professional learning community established as a South African community of practice response towards enhancing and supporting transformative environmental and sustainability learning through teacher education in the country” (Fundisa for Change, n.d.) to help teachers teach sustainable development subjects’ content better.

The same **technical inquiry** was applied in the Mpophomeni case. Unlike in the teachers' case, the Mpophomeni case' project targeted young people who were living in a culture of unemployment. Since the NGOs strongly supported the citizen science project, I first conducted research with GroundTruth because there were active sites available at rivers under stress. These rivers were feeding into Midmar Dam and GroundTruth, in partnership with other NGOs like DUCT, had a common interest in alleviating those stresses. From this research, I identified a number of aspects about how

participants improved scientific impact (over time and space), and how their participation in water quality management could ultimately improve:

- More **mini-SASS data collection and manhole monitors** (see Chapter 8, issue 3) reflected on the miniSASS map,
- Better **reporting methods, reporting skills and understanding of the river's health** (see Chapter 8, issue 1, issue 3, issue 5)
- Careful **observation of the change in behaviours of the community** toward environmental and river management, also the **change in the attitude of the government officials** (see Chapter 8, issue 3, issue 6)
- Participants' empowerment and skills learning such as **stakeholder liaising**, for instance, forming part of the war rooms meetings, building trust and buy-in from the community, negotiating with the government officials, schools, parents, hardware store, etc., (see Chapter 8).
- **Environmental monitors** such as Ayanda Lepheana eventually **found full employment** with GroundTruth **with a proper job title** (ecological technician) (also see Chapter 8, issue 3).

The above-mentioned activities offer substantial evidence to sustain the claim in this thesis that the **participants in the citizen science practice need to be given a job title that matches the contribution and value they provide to the project, rather than simply labelling them volunteers**. For instance, the above activities illustrated that the participants were providing ancillary support to the practice. As a result, they could be easily named data collectors, environmental monitors, field-report writers, community behaviour observers, and ecological technicians as entry points to careers in journalism, social science, environmental education, etc. These activities also illustrate what is absent or lacking in practice, that there seemed to be more data collection than data analysis or interpretations that could precisely translate the scientific meaning of collected data into social meanings with implications for policymaking. Thus, data interpreters are needed, as they play a fundamental role in intersection A in the model introduced above.

In order to understand the studied sites and their systems, both Mpophomeni enviro-champs and Vaal-Triangle primary school teachers, more deeply and what accounts for them, I reached for critical realism and Margaret Archer's social realism so I could understand the structures (material resources – both physical and humans); cultures (rules, ideas, interests); agency; relations (internal and external; connected or not); and their histories and inheritance (see Chapters 6, 7, 8 and 9; Archer, 1995). I further looked at their implications for outcomes, both intended, emergent and oppositional, for deepening the realist(ic) evaluation. This was because they shaped the participants' (i.e. all

participants involved) doings, thinking, interactions, reflexivity and relationships (see Chapters 6 and 8) and the intervention's progress. Hence, the realist evaluation by Pawson and Tilley (1997) alone did not provide a deeper understanding of these **underlying 'conditional and generative mechanisms'** (Archer, 1995, p. 16) operating within contexts until I was able to focus on issues, i.e. subject matter (Porter, 2015a). In addition to Margaret Archer's realist social theory, I drew on, in particular, the people emergent properties (PEP), cultural emergent properties (CEP) and structural emergent properties (SEP), which provided insights into the conditional and generative mechanisms of the contexts. Through these citizen science tools, I could further explore the study's phenomenon, the uptake and use of the citizen science tools.

As a result of my initial analysis, I came to realise the necessity of **reconfiguring the notion of volunteerism as public participation in the context of ubuntu ethics** and in the context of the emerging body of work that focuses on working for the common good (Lotz-Sisitka et al., 2022). I have been part of parallel projects indicated in Chapter 1 on scaling CBWQM using citizen science tools (ibid.). Grassroots citizen science projects informed this initiative via GroundTruth and DUCT, the present research study as well as research studies, especially that of Vallabh (2022) focusing on citizen science, and ecologies of knowledges and the strengthening of relational knowledge-building in response to social-ecological risk. The initiative recommends the need to develop business financial models (Lotz-sisitka et al., 2022) to support the effective and transformative participation beyond volunteerism by young people and communities in the water management sector. Together with this study, the initiative intends to improve policymaking processes while simultaneously improving the quality of life. This study illustrates that volunteerism is not enough because of the scourge of poverty and unemployment of youth in Mpophomeni, South Africa and Africa, which also challenges the assumption that public participation through citizen science in water management can be translated into proper employment and be legitimised in the education system. Citizen science practice can simultaneously and significantly improve SDG 6 – clean water and sanitation, SDG 4 – quality education, SDG 1 – no poverty, and SDG 8 – decent work and economic growth. It requires more substantive investment from the policy sector.

10.6. Part 5: CMO analysis of issues

10.6.1 CMO configurations and mechanism insights

In parallel with the above, I worked with collected data to analyse the **Context-Mechanism-Outcome (CMO) patterns from both the structural and issue-based/agency dimensions**. Firstly, the layout of the presentations and CMO configuration insights varied per case (refer to Chapters 6 and 8). The data showed that while both analysis processes were equally iterative, the teachers' case represented a complicated system, whereas the Mpophomeni's was a complex one. The process of unpacking the

CMOs from the teachers' case was more straightforward, perhaps due to their rootedness **in a fixed structure**, e.g. the education system and the curriculum set-up but at the same time this limited the teachers' agency. As a result, teachers' interaction patterns and outcomes could to some extent be easily predictable (see Chapter 6). Similar to the Mpophomeni CMO configurations, the Vaal-Triangle primary school teachers' relationships were presented as straightforward and linear, but in reality, **they were complicated** and interdependent (see Chapter 6). In the end, one must demonstrate how the mechanisms are separate as parts of the system. Hence an overall analysis of the issues and CMO Configuration insights in Chapter 6 were summarised below as the six significant CMO relational patterns (with accompanying evidence) when observing the uptake and use of the citizen science tools in public primary schools. These patterns were developed to emphasise what accounts for the issues elaborated in Chapter 6 in the CMO configurations in the thesis.

In addition, the process of evaluating the Mpophomeni CMO patterns and CMO configuration insights was **complex**, perhaps because of the fluidity of the structure/system they were operating in, e.g. Mpophomeni community and some parts of the project design and implementation. Both systems were continually changing, interacting, interdependence, heterogeneous, and carried deep histories (see Chapters 6, 8 and 9).

Meanwhile, the evaluation of CMOs did not provide clear differentiation between what was intended (i.e. implementation theory) and what emerged/response (i.e. programme theory) due to a lack of clear documentation with clear objectives of why the intervention was introduced in the two contexts, the study provided evidence of what specific activities brought about what outcomes (see Chapter 2, Chapter 8 and the table below). It is work that can be taken forward for a Strength Weakness Opportunity and Threat (SWOT) analysis and monitoring and evaluation in future citizen science projects. It can also help improve the programme theory of the CS interventions going forward.

The first four contexts addressed the structural cultures of the project, and the last two addressed the agency of the participants; however, the structure and agency are crucially ontologically interconnected (Archer, 1995).

Table 10.1: Summary of the intervention's most strongly observed contextual and mechanism enablers or constraints that determined success. These can be used as the evaluation steps for assessing layers of contexts to unpack the uptake and use of citizen science projects in the two cases. The mechanisms and outcomes are found and described in more detail in Chapters 5, 6, 7, 8 and 9.

Context of Vaal-Triangle primary schools	Context of Mpophomeni enviro-champs

1. The need to align stakeholders' ⁷⁵ missions and purposes of the intervention through citizen science practice in the Vaal-Triangle public primary schools (see Chapter 6, issue 3b, issue 4, issue 5, issue 6).	1. The need to align the district and local municipality, and NGO and 'community' management visions, values, their relationship histories and ubuntu (see Chapters 8 and 9).
2. The need to align the municipality's intra-department management (see Chapter 6, issue 7).	2. The need to align the institutional visions, ethics and community aspirations, their relationship histories and ubuntu (see Chapters 8 and 9).
3. The need for the government to develop capacity for the school management to provide efficient support to the citizen science practice (see Chapter 6, issue 2, issue 3).	3. The need for the alignment and marriage of institutional visions, ethics, individual members' aspirations, their relationship histories and ubuntu (see Chapters 8 and 9).
4. The need for careful timing in introducing the citizen science tools and practice to the teachers (see Chapter 6, issue 1). Curriculum alignment and professional development.	4. The need to monitor and assess the citizen science project cycle and the capacity for individuals to take up and use the citizen science tools (see Chapters 8 and 9).
5. The need for teacher-to-teacher support in taking up and using the citizen science tools (see Chapter 6, issue 2).	5. The need to support the enviro-champs' support of each other, of the community and other stakeholders and ubuntu (see Chapters 8 and 9).
6. The need to support the teacher's degree of willingness and determination to take up and use the citizen science tools (see Chapter 6, issue 2).	6. The need to support the enviro-champs' degree of willingness and determination to take up and use the citizen science tools and ubuntu (see Chapters 8 and 9).

10.6.2 Challenges faced with analysis in the two cases

The following were the challenges faced and comments when analysing the two cases using the realist evaluation theory:

(a) The need for documentation of the monitoring and evaluation strategy and reports for a point of reference

The uptake and use of citizen science tool project introduced to the Vaal-Triangle primary school teachers and Mpophomeni enviro-champs **did not have a monitoring and evaluation strategy or framework or reports** – M&E reports or framework are one of the 'starting' components of realist evaluation/ programme theory when assessing an already existing programme. As such, I **did not have**

⁷⁵ Stakeholders here include Department of Basic Education, Department of Water and Sanitation, municipality departments, government agencies such as Rand Water, and the community.

point of reference to add to or understand my findings in relation to previous evaluations. The ability to develop a new evaluation gauge for the project under these circumstances has added another feature and opened further deliberations to realist evaluation theory or programme theory.

(b) Difficulties in reconstructing historical evidence to influence real-time change

I have noted the problem with “conducting a post hoc evaluation is that most of the data needed become difficult to be reconstructed” (Tilley, 2000). For instance, in the case of the teachers, I had to explain the social science theory in reverse and the discontinuity of the programme – what 'ought to be' and 'was' – i.e. **the historical evidence**. A series of interviews were needed to tease some concerns about the circumstances required to create outcomes at the time of the introduction and execution of the programme. It was challenging to organise such historical evidence into influencing policy processes. However, it was worth reflecting on the mechanisms (e.g. old and real-time evidence – events, actions, thoughts; document analysis; literature; etc.) that could bring about change to improve the programmes for better outcomes (Pawson, 2002; Tilley, 2000). The lessons learnt from the past might be limited. However, I relied strongly on value-laden social facts, which then gave bases for analysing issues and value conflicts.

(c) The timing of the intervention was as crucial as the tools and properties of the agent to generate effective change

The evaluation research cycle of the intervention, which looked at the causation/change in the intervention, was not only dependent on the uptake and use of the citizen science tools alone but also on the properties of the agents/objects (Sayer, 2005), and was dependent on the timing of the intervention. Pawson and Tilley (2004) explained that every programme ought to have an **evaluation research cycle (design, implementation, impact)**, and this study illustrated that the cycle ought to be **aligned to the timing of the intervention** (refer to Chapter 6). However, in this study, this was not the case. The design and implementation were over-generalised, and the impact of the intervention was not measured. In the case of the primary school teachers, the timing for the introduction of the uptake and use of the citizen science tools was poor. They were introduced at the time when the module for water content had passed and could not be repeated the following year for revision. This study then investigated the impact of this cycle and evaluated it.

(d) Temporal conditioning made it difficult to develop a flow of systemic evidence and understanding of the intervention

In the case of the teachers, the programme was set up as **temporal conditioning**. As such, advancing it and developing a more extended view, as Pawson (2002) suggested, could inevitably be challenging and it was **difficult to build a flow of systematic evidence and understanding**. Specifically, the structures and cultures of the public schools in South Africa are generally established on politics (refer to Chapter 1 – Policy review, Chapter 6 issue 8). Also, it was difficult because the citizen science project was based on the assumption that those who participate ought to have or develop individual/collective agency. Therefore, it was daunting to evaluate what worked, primarily as the programme was not integrated into the school system and was not adequately supported.

(e) Realist evaluation (CMO configuration) or programme theory is inevitably trapped in the social semiotics – the interpretation and explanation of the 'meaning of poverty and what is ethical' between 'the definer and the defined'

At this point, it is essential to be reminded that realist evaluation is founded on critical realism ideologies pioneered by Bhaskar (see, for example, Bhaskar, 1998). Later Archer (2000) developed and critiqued the reductionism⁷⁶ concept in her social theory – where she firmly argued that the social fact cannot be reduced to the individual behaviour yet the sum of the individual behaviours and their relations produce and/or trigger emergence of social fact(s). Her reason for being an anti-reductionist is that in the process of reducing bigger or complex problems into smaller, simpler parts, some views of the problem get lost or rather, causation or change cannot only be explained and understood via a unilateral process. Her theory, drawing on the work of Bhaskar, is based on the notion that reality in 'nature' is differentiated, stratified and has emergent properties. It must be understood in its realm rather than reduced to another level.

However, exploring Bhaskar's and Archer's ideas in a realist evaluation theory (De Souza, 2013; Pawson & Tilley, 1997) and programme theory (Weiss, 1997) applied in this study helped to articulate the question of **'what works for whom under what conditions and why?'** – a question that in itself became an inquiry rooted or mixed in the **post-disciplinary (or transdisciplinary), post-theoretical (transtheoretical), post-sectoral (or trans-sectoral)/ post-regional (or transregional) learning**. Because of the complexity of the study's concern, context or its reality, the question 'what works for whom under what conditions' was more concerned about the evaluation *of the intervention* in context, rather than the evaluation of the programme theory (Mukumbang et al., 2019) or any other

⁷⁶ By reductionism here I mean whether the issue is explained or interpreted in a one sided view, in one discipline, in a form of prediction – informing policies, vertical or horizontal reductionism, downwards or upwards reductionism, etc. (Sayer, 2005)

theory⁷⁷ for that matter. This was a daunting activity particularly as the meaning of the concepts of **poverty and ethics**⁷⁸ (and their implications and their powers or lack thereof) formed the basis of the context. At the same time, it was daunting to balance such meanings in the discourse. The ambitions and methodological rigour of the discipline in the study were rooted in environmental and social education in an academic setting and a problem of *disciplinary imperialism* emerged (I add structural imperialism) as explained by Sayer (2005).

In summary, who or what defined 'what is or what is not' did stimulate or prevent change in the intervention. For example, in this study, it was demonstrated that how change was perceived and affected was different within the enviro-champs, i.e. various members were impacted differently by the intervention (in time, space, scale) (see Chapters 8 and 9). The teachers' backgrounds varied from teachers within one school and across schools and they were affected differently (see Chapter 6). In both case studies, I demonstrated how the intervention was connected to other interventions (agential, structural and cultural) within and between programmes – school-to-school, school and community, teachers-to-teachers and English vs Social Science subjects. Also, in the case of the enviro-champs, the complexity of the relationships was demonstrated between the municipality ward and enviro-champs, between the old and the new members, accumulation of knowledge over time, and so on (see Chapter 8 and 9). Ultimately, it was about a matter of influence by individuals or community, **focusing on what they have control over** rather than concerned about issues they do not have control over like politics, social status, etc.

Working with the analysis helped to investigate deeper the nature of realist evaluation theory and its expansion (see Chapter 2) assisted in unpacking the assumptions and expectations of the citizen science practice intervention from the intervention developers' point of view, the subjects' points of view and the context of implementation. It offered an overview of realist evaluation and added morphogenic tools to interpret the phenomenon in more depth, revealing insights that can contribute to hydro-sociology and hydro-hegemony studies, as well as environmental education praxis, and how CS tools uptake and use can be supported in diverse complex contexts, which was a key focus of this work.

⁷⁷ The meaning of theory here is scholarly/scientifically acceptable general principle or body of principles offered to explain phenomena.

⁷⁸ Putting the concepts of poverty and ethics in the same discourse as the concepts of 'empowerment', 'citizenship', 'informed decisions', 'public participation and engagement', 'volunteerism', 'learning and social learning', 'self-interest', 'benefits of others and environment' in South Africa and Africa needed a 'unique' in-depth analysis of mechanisms because of their distorted interpretations and implications of the known political, economic, socio-ecological, spiritual historical properties.

10.7. Part 6: What works for whom, under what circumstances, and why?

As shown in the Chapters 6, 8 and 9, answers to this question could potentially be found through exploring or engaging with the participants' contexts (Chapters 5 and 7) and their **aspirations, hope** and **other reasons for staying** in the project (see also Chapters 6, 8 and 9). In Chapter 9 it became clear that the participants' aspirations and hope was fixed on getting employment and other material things that would change their lives. Teachers wanted interventions that were better aligned with their responsibilities and teaching practice conditions. In the enviro champs context, another reason was to gain dignity and respect – in terms of ubuntu they needed to be seen participating in something that could uplift their society. According to Thandanani Luvuno, “another reason the enviro-champs were loyal to DUCT was that they could equitably sit together to plan the project and plan how to take it forward. This gave us as participants a sense of belonging and ownership of the project” (T. Luvuno, personal communication, February 12, 2016).

From the quote above it could be seen that valuing and trusting each other's contributions equally during the planning session was fundamental. As a result, the project became meaningful because it brought a sense of belonging, shared vision, creation of own value(s) and accountability, enabling effective implementation (see Chapter 8 and 9). This co-creation and co-engagement in the project which motivated other participants was not the same for the teachers who felt burdened by the intervention's activities (see Chapter 6) which were not formally regarded as part of the curriculum or incentivised. As a result, receiving support from the teachers was a challenge, resulting in an end to the project.

In conclusion, there is still much to be done to effect an optimal and radical change in both cases. Therefore, we are not at the end but the beginning of something. The water continues to flow, and where it flows, it breaks and heals.

10.8. Recommendations

The following are recommendations for further research that emerged from the study:

10. 8. 1 Inclusion of Gender Context in Water Issues and Citizen Science Practice Interventions:

The two case studies under examination, which center on the enviro-champs and the Vaal-Triangle primary school teachers, shed some light on the diverse impact of water issues on different genders, influencing their agency and participation in water-related endeavors. Although the available data did

not extensively explore gender dynamics, acknowledging the importance of addressing gender context in the context of water issues and citizen science practice is crucial. For a genuine and meaningful transformation in water quality management and citizen science initiatives, future interventions must explicitly incorporate gender considerations. Integrating gender-sensitive approaches can significantly enhance the effectiveness and inclusivity of water management initiatives and citizen science projects (Graham et al., 2003; Pearson et al. , 2017; Vignola et al., 2014).

The pursuit of a sincere and impactful transformation in water quality management and citizen science endeavors necessitates the explicit integration of gender considerations in forthcoming interventions. Embracing gender-sensitive approaches is fundamental to augmenting the effectiveness and inclusivity of water management initiatives and citizen science projects. Valuable insights from studies conducted by Graham et al. (2003), Pearson et al. , 2017, and Vignola et al. (2014) further emphasize the benefits of adopting gender-sensitive strategies in environmental management and scientific research. They argue that gender is a critical factor that influences how individuals experience and interact with water-related issues and citizen science initiatives and that recognizing and addressing gender dynamics are essential for understanding the social dimensions of environmental challenges and ensuring that interventions are tailored to the specific needs and perspectives of different genders. By acknowledging the gendered impacts of water issues, policymakers, educators, and practitioners can design more targeted and effective solutions as this can foster more equitable participation of all genders in water management and citizen science projects. Inclusive participation in turn can enhance the quality and relevance of data collection, analysis, and decision-making processes, leading to more robust and sustainable outcomes that can strengthen environmental and social sustainability, enhance policy effectiveness and address knowledge gaps. I therefore recommend further research into the explicit integration of gender considerations in future interventions, to deepen understanding at point A in Figure 1.2 and 10.1. More studies are needed to provide more nuanced evidence supporting the value of gender-sensitive strategies in promoting equitable participation and environmental sustainability.

10.8.2 Upscaling and Continuous Support for Teachers' Professional Development in Water and Environmental Education

This study has pointed to the need to give more attention to the importance of Upscaling Teachers' Professional Development when it comes to use and uptake of CS tools and their alignment and integration in the curriculum. This is necessary to promote quality education in South Africa and enhance water and environmental education in public schools, prioritizing the upscaling of teachers' professional development is essential. By investing in comprehensive and ongoing training for educators, policymakers can equip them with the necessary knowledge and pedagogical skills to

effectively deliver high-quality water-related content and broader environmental education in classrooms across the country. One mechanism that exists for this is the national Fundisa [Teaching] for Change initiative which develops materials and programmes for teacher professional development to enhance transformative environmental learning in schools (Schudel, Songqwaru, Tshininganyamwe and Lotz-Sisitka, 2020). Currently the Fundisa for Change programme has modules on water education, but they do not have a formalised programme on the uptake and use of CS tools for water quality monitoring even though this is an activity that can be developed in the formal curriculum. Endorsing and allocating resources to established programs like Fundisa for Change offers a strategic pathway to achieve the upscaling of teachers' professional development in CS for water quality management and environmental education. Fundisa for Change is a well-established program that focuses on enhancing teachers' expertise in environmental and sustainability education. By investing in this initiative, policymakers and educational institutions can provide continuous training and capacity-building opportunities, ensuring teachers stay updated with the latest knowledge and innovative teaching methodologies. Research in the Fundisa for Change programme shows that such programmes have a positive impact on students' environmental literacy and pro-environmental behaviors and on the quality of teaching and learning, and that they address some of the structural challenges identified in Chapter 8 (Schudel et al., 2020). It is therefore recommended that a CS module / professional development programme be developed for the Fundisa for Change programme drawing on insights from this study as reported in Chapter 5 and 6.

10.8.3 Further research on the spirit of ubuntu and the differing perspectives on volunteerism in CS in Africa

This study has identified the spirit of ubuntu as being a significant influencing perspective on volunteerism in the two case contexts. Deeper insight into this was gained in the enviro champs case in Mpophomeni, probably also because the practice was more established in this context over a longer period of time. The data offered rich insights into this perspective and it also helped to differentiate types of volunteerism that could be more relevant for the African context that can also address the contextual challenges, most notably a type of formalised, supported volunteerism that is backed with employment options. The study showed however, that the type of volunteerism was also motivated by care and concern for social cohesion, democracy and well being and a striving for a life of dignity as well as livelihoods. As argued across this study, care should therefore be taken to avoid reductionism in interpreting CS practices. Much more in-depth research can be undertaken into this important phenomenon in CS practice going forward, particularly if also framed with more depth analysis of power relations, agency formation, and histories of hydro hegemony in colonial historical

contexts such as those investigated in this study. I therefore recommend further research into this phenomenon in CS practices going forward. The relationship between intrinsic and extrinsic motivation in this context was also interesting and can be further researched.

10.8. 4 Citizen Science tools innovation and IQWM policy advancement:

The study also pointed to the importance of citizen science tools innovation that have relevance and meaning at local levels where complex issues are experienced. Reporting processes linked to these tools, especially integration of the use and uptake of the tools into local governance processes and political structures seemed to be a significant aspect of the CS tools uptake and use. Further research can also be conducted into this aspect of CS practice in South Africa, conceptualised as an important feature at point A of Figure 1.2 / Figure 10.1. where public participation is important to develop in democratic governance, and thus also for more effective policy implementation and IWQM policy advancement. Further research can also be undertaken into this aspect of the findings of this study.

10.9 Conclusion

In this study, realist evaluation enabled me to understand and represent **context** differently in a citizen science project. It helped to unearth hidden contextual dynamics such as structures, ideologies, practices, beliefs, circumstances, time, space, etc. (Greenhalgh & Manzano, 2021) (see Chapter 8; Chapter 4, section 4.5.1.1). In Chapter 4 I discussed the CMO configuration, which offers a methodological approach for evaluating and analysing a situation and the interacting and shaping mechanisms. In this study, the focus was on the intersecting contextual mechanisms related to community-based water quality management and citizen science uptake and use of tools.

Context then was further and separately deconstructed in the two cases of the Mpophomeni enviro-champs and Vaal-Triangle primary school teachers. Moreover the study was inevitably embedded within different disciplines, including education, environmental education, social (and political) science, natural science and policy, which in themselves create different knowledges; therefore, the definition of context becomes even more complex. Because of such diverse perspectives and different practices, context, then, is not the same thing. Even deeper, the study revealed that context must be perceived as something enacted in practice (depending on who is doing it, where the starting point is and for what purpose) (see Chapters 5 and 7) and in different ways rather than be perceived as something static that 'just sits there'. Hence there is a need to pay attention to context, recognising its situated complexities, and thus giving deeper attention to what is meant by context in realist evaluation.

As shown across the study, in linking context to fair and meaningful public participation, depending on the entry point and the project progression, certain aspects become inevitably salient for

understanding the context for the intervention (e.g. volunteerism and environmental advocacy). In contrast, others become absent or end up in the background (e.g. the need to address the socio-economic background of the volunteers in the intervention). For example, in the beginning, the project developers clearly instructed the enviro-champs to be apolitical about the intervention – politics were deemed an irrelevant part of the intervention and their volunteering context, which then absented the participants' concerns/logic (see Chapter 7 – the political fabric of Mpophomeni community). However, as the project progressed, the enviro-champs realised that change could only happen if they could strategically engage in political structures such as war rooms (see Chapter 8 and 9). Therefore, how the context is enacted in practice brings the question of power and relevance/meaningfulness, and how boundaries are drawn. Firstly, what or who decides what is important or not and relevant for the context (i.e. responding to what works for whom – from Pawson and Tilley's question). Secondly, there is the question of who can see themselves or their lived experiences in the enacted context of the project.

In closing, and in addition to Greenhalgh and Manzano (2022) definition's of context as 'observable features or things' and 'relational and dynamic features or forces/interactions', the study argues that context must continuously engage with the question of what goes with the description of the project and research object. And why? In this way, context becomes very important as enacted, and as something that is actively constructed, deconstructed and reconstructed to create meaningful citizen science interventions. It moves and evolves, with mechanisms interacting and influencing each other, can be material and/or immaterial (Greenhalgh & Manzano, 2021) and can be hidden, subtle and/or explicit. Thus, working with the combinations of in-depth elaborations of context(s) and associated dynamic mechanisms of structures, cultures, ideologies etc. and how these relationally, trigger the more practical mechanisms or activities of the intervention (s) and the uptake and use of citizen science tools in particular contexts, is a contribution to realist evaluation theory as applied to citizen science practice. Furthermore, the situatedness of this research in Africa via consideration of ubuntu as an ethical philosophy helped to further deepen this contribution, as this added nuanced understanding to the dynamics and of context (s) and thus the CMO relation.

The study contributes insights to both practice and policy. It emphasises the need to approach public participation as a qualitative process characterised by careful and intentional consideration of the terms of participation, and how partnerships with local communities are established. For citizen science practice, it proposes further depth of understanding into the context of enviro-champs and primary school teachers and how this influences their participation in such practices and thus the uptake and use of the tools, including through tools innovations. The study, therefore, contributes to

a deeper understanding of participation and how to better effect and evaluate participation in the uptake and use of citizen science tools in South Africa, and thus informs public practice and government policies on water quality management, especially governance commitments to include communities in integrated water quality monitoring practices in South Africa, which as argued in Chapter 1, are rhetorically well established in policy, but poorly implemented in practice.

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Appendix 1: Questionnaire sent to attendees of the February 2016 citizen science workshop

	WHAT IS YOUR	Which Tool (s) have you used or intent to use (Please tick)				What type of water body/bodies do you work in?	Why did you choose the tools you chose?	What are your	What do you want this workshop to do for you?/What is your purpose of attending this workshop
What sector or grouping would you categorise yourself as? Please circle/tick	Geographical Location (e.g. Country + Province + Municipality + town/village, etc.)	MiniSASS (Manual + App) (M+A)	Water Clarity Tube	Velocity head-rod	Other water quality citizen science tool (s)	Water body (e.g. stream/river, dam, wetland, etc.)	Motives (e.g. work purpose/personal)	Successes or barriers so far	State your reason (s) below
Group 1- Eco-schools									
- Teachers									
- Learners									
Group 2 - Schools									
- Teachers									
- Learners									
Group 3 – Farmers (Commercial/subsistence)									
- Livestock									
- Crop									
Group 4 – Government/ Private Officials/Institutions									
Group 5 - Scientists									

Group 6 – Individuals / Community groups									
- Individuals									
- Community group									
Other									

Appendix 2: Questions asked during the interviews with the teachers and principals

Field work questions (for the teacher)

1. What citizen scientific tools were available as a “generalizations” for application into diverse context?
 - Technical knowledge questions
 - Take me through the instruments and tell me what each does.
 - How do you find the instructions about the use of the tool?
 - What do you learn from each instrument?
 - What does the knowledge mean to you or in your context?
 - What part of the instrument is difficult or easy to use? Why?
2. What influenced citizens to take up and/or use the citizen science tools? (influenced allows the following to emerge– relations, reasons & aspirations (motive), mechanisms)
 - a. From the teachers’ point of view/ agency (Structure Culture Agency)
 - Which tools work for whom under what circumstances?
 - What was the water quality conditions like before the introduction of the citizen science tools?
 - Who was involved, and how were you involved?
 - What were the mechanisms or tools used for water quality monitoring before the introduction of the citizen science tools?
 - What were the conditions and aspirations for you to take up and/or use the citizen science tools?
 - How are the water quality conditions now?
 - Who is involved, and how are you involved?
 - What changed/not and how did it happened?

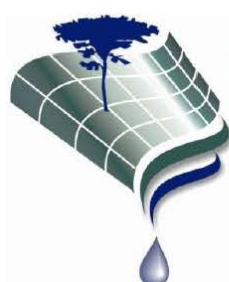
- Did you receive any training regarding the tools?
- How did you find the training?
- How relatable was the training? Why?
- How would you describe your relation to the people who introduced the tools to you? Who are they?
- How would you describe the relation with people you are working with in this citizen science tools practice? Who?
- How would you describe your relation with the society especially when you were taking up and using the tools? Who?
- What does water quality mean to you?
- What tools did you take up, and what tools did you use? How and why?
- What tools are you still continuing to use? How and why?
- What were the barriers and successes in taking up and/or using the tools?
(Social/ institutional structure: physical, material resources, practices [by HR]; Cultural: what ideas are shaping and shaped by people; Agency: intentions and reflexive self-monitoring, competencies, capabilities)

What could be done to improve the efficiency and/or the sustainability of the uptake and use of the citizen science tools?

Appendix 3: Interview schedule of the data collection from key informants of the pilot study for contextual profiling conducted via GroundTruth

Study Site	Activities	No. of Participants	Date
Mphopomeni enviro-champs	Method 1: Open-ended semi-structured interview	(2)	February 2016
DUCT member	Open-ended semi-structured interview	(1) Liz	February 2016
WESSA members	Open-ended semi-structured interview	(2) Claire and Jim	December 2015 February 2016
Citizen science tools researchers	Open-ended semi-structured interview	(2) Tich and Rob	July 2016 October 2016
Emfuleni municipality	Open-ended semi-structured interview	(2)	April 2016
Vereeniging and Evaton schools visited	Open-ended semi-structured interview	6 schools with at least three participants per school	From August 2016 to September 2016
Metsi-a-Lekoa	Open-ended semi-structured interview	(1)	September 2016

Appendix 4: A GroundTruth letter of request for participation sent to schools, i.e. teachers and principals



GroundTruth

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Environmental Engineering*

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Project Ref: GT0471/08/16

August 2016

Dear Research Participant

My name is Ms. Morakane Madiba. I am a PhD candidate in the Environmental and Learning Research Centre (ELRC) at Rhodes University under the supervision of Prof. Heila Lotz-Sisitka. I am currently conducting a research project in partnership with GroundTruth who are implementing a research project for the Water Research Commission entitled:

‘Development and Innovative Use of Community-Based Water Resource Monitoring Tools to Research and Mainstream Citizen Science and Improve Trans-Boundary Catchment Management’

My task in this project is to contribute insights into the successes and barriers associated with the uptake and use of citizen science tools. I will be using a realist evaluation framework that asks the question; **‘what works for whom under what circumstances and why?’**

This research aims to improve practices in the field of trans-boundary water quality management by informing policy makers and practitioners about engaging with citizens through the use of citizen science tools.

I would like to request your participation in this pilot study so that I can develop an understanding of who uses what citizen science tools and for what purposes. Later, and once the first phase of analysis is complete, with your permission I would like to visit your site to develop an in depth understanding of the successes and constraints with regard to the uptake and use of the tools. Your

Reg no: CK 2004/118210/23

participation will be invaluable to this study, and I therefore request access and permission to conduct the study on your site.

According to the ethics protocols for educational research, you may of course withdraw your permission to participate at any time throughout the research process. There are no foreseeable risks in participating in this study and it should be noted that the participants will not be paid. I ensure that I will check any interpretations of the data. I also ensure that your anonymity will be maintained and protected as is standard with the identities of research participants.

All data and transcripts captured from our interactions will be stored in a safe, private and secure place, and will only be accessed by the research team members. You are welcome to ask any question about the study at any time. I will share the findings with you and we can discuss any response, ideas or concerns that you may have.

By signing the below declaration you are confirming your participation in this research.

I, ... (name and surname) have read and understood the above conditions relating to participation in this study and agree to participate fully to the best of my ability.

Appendix 5: Letter to the schools suggesting dates for visits

Suggested dates and times on when your schools are going to be visited

Dear All

As per the emails I have forwarded, please look at the suggested dates below for my visit to your school and please respond as soon as possible if the date and/or time is not conducive for your schedule and suggest them. Otherwise I will come on the dates as suggested.

Please note: If the suggested educator is not available please recommend another who was also involved in the River Learning box project **OR** was taught by those who were involved.

And I thank you very very much for your cooperation.

Regards,

Morakane Madiba, Ms.

Appendix 6: GroundTruth consent form sent to teachers and principals

CONSENT FORM: Evaluation of the successes and barriers of the uptake and use of citizen science tools to improve the trans-boundary water quality management

I, (Name and surname) _____ give my consent for the following (circle your answer):

- I agree that my employees or learners work with Morakane Madiba from Rhodes University, provided that they also give their personal consent, and the information collected must only be used for this study.

YES/NO

- Permission for my employees or learners to be interviewed and audio-taped for this study, provided that they also give their personal consent.

YES/NO

- I know that I can stop the interview or interaction at any time and don't have to answer all the questions asked.

YES/NO

Informed Consent

I understand the following:

- My name and information will be kept confidential and safe
- My name and the name of the institution where my employees are situated will not be revealed unless I otherwise agreed
- I am not obliged to answer every question
- I can withdraw from the study at any time
- Only people involved in the study and / or people who have obtained my permission may have access to the data

Signature: _____ Full Name: _____

Date: _____

Reg no: CK 2004/118210/23

Appendix 7: Consent form distributed to the participants attending the international citizen science workshop

Researcher: Morakane Madiba

Position: PhD candidate in the Environmental and Learning Research Centre (ELRC)

Institution: Rhodes University

Supervisor/s: Prof. Heila Lotz-Sisitka (co-supervised by Dr Jim Taylor and Dr Mark Graham)

Evaluation of the successes and barriers of the uptake and use of the citizen science tools for the improvement of the trans-boundary water resource (s) management. A case study of South Africa (uMgeni and Emfuleni) and Botswana.

Consent Form

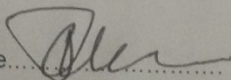
I am currently conducting a research project under GroundTruth that aims to evaluate the successes and barriers of the uptake and use of citizen science tools to improve the trans-boundary management of catchments/water resources. My research interest is based on analyzing different types of citizen science tools in terms of appeal, use, efficiency and sustainability (in special relation to the co-management of water resources).

The purpose of this questionnaire is to obtain a general understanding of who is using citizen science tools and for what purpose. Your participation will contribute to the knowledge of citizen science practices and will be greatly appreciated. Please note that you may be contacted for a possible follow up interview.

Your information will be kept confidential and anonymous. Should any information arising from your participation be requested outside of the project, your permission will be requested in advance. In this study you will be quoted under a pseudo-name. All data will be stored in a safe, private and secure place and will only be accessed by the research team members.

If you have any questions please feel free to approach me at the Citizen Science workshop on the 11th and 12th of February 2016 or email me at: madibam3@hotmail.com

I, Jemo w. Ngweni have read and understood the above conditions relating to the participation in this study and agree to participate fully to the best of my ability.

Signature 

Date 12/02/16

Appendix 8: Transcript for the enviro-champs

In form of notes taken by Mike Ward during our shared interviews.

Key:

Number of times

Existence of something (structural)

Psychological, cognitive, Affection, Physiological, Economic, Sociological, economic, Sociological, organizational process

- Amount of knowledge
- Heightened interest
- Motivations
- Anxiety
- Motivational responses
- Choices made

Programme activity

Outcome

Context

Transcript notes from Mike Ward (Colleague from Rhodes), whom we shared the interview.

Ayanda presentation at the International Citizen Sciences

Contest

Very beautiful place but we have some challenges

Spilling manholes

Illegal dumping

Water leaks

It just goes straight to midmar dam

Photo

Midmar dam is under threat as a result of the sewage sillage that happens in Mpoponei

Infrastructure failure (placed in the way.)

International students and national students come to Mp to see the tools we are using – how the tools are helping us. 2014 200 occ – already in 2016 are approaching 200

Mechanism

Initially we had 10 EC. Now UMDM have asked to have 20 envirochamps working full time (from 2011 to Oct 2015 they were doing the work voluntarily) ... Programme activity....target group

60 manholes that they are currently monitoring... program activity

All of the manholes have been GPS mapped... program activity

Spreadsheet with the manholes listed by the Enviro Champ names... (program activity) – take responsibility. Start of the month ecs get form at the end of the month AL puts all of the information into spreadsheets...(program activity) Pivot tables provide substantial amount of information eg spilling, fixed... (Program activity)

Have developed google earth map with this information (program activity) – picture of the enviro champ responsible and information on the manhole.

Looking at colour coding manholes based on spillage.

Have information going back to 2011. Originally each ec monitoring one mh each 2012 to 2013...(program activity) ..(number of times)

From 2013 dec and jan 2014 no funding could not even print the sheets...(anxiety) But continued to report the blockages – but did not capture the data...(choices made) In 2014 each env champ managing 8-10 manholes...(amount of knowledge). December 2015 very large decline in the number of reports...(outcome)

20 EC doing door to door to discuss the env challenges that we face...(amount of knowledge - ..confidence).

Walk along the Mtinzima stream.

** monitoring the outflow from the Howick sewage works

Relationship with govt - good relationships with govt. Dept of Water and sanitation...(existence of something – relationship). (Name) will come around and pay a visit and will get the other managers around to look at the problems...(number of times – to see progress)

The theatre team...(emerging outcome) Play about what must not throw in the toilet (emerging outcome...creativity).

Door to door discussion – also has been saying that they do not access to...(amount of knowledge – confidence + outcome)

D2D 20 env champs the ecs do discussions with the communities about the issues that they have and even the social issues...(amount of knowledge – confidence – heightened interests) Every Tuesday there is a training on what needs to be covered on the D2D... (existence of an activity + outcome)

Kids conducting mini SASS every second Sat of month take the kids for walk...(program activity) – all of the env champs come together (96 kids from Mp at the last walk)...(outcome) Max number that each Env Champ is 15 and meet with them every Friday responsible for teaching them about env using the tools that has shown...(program activity)

Champs work with the schools in their areas...(existence of structure – networking..choice + outcome)

Use the educational poster with the good and bad – compare to the streams that they have – discussion...(program activity)

Has a list of tools that they have been using

Env selectec partly based on the proximity to manholes. But where the manholes are distant it has got to the ont where community members let the ECs know if they are leaking...(existence of something – relations – trust)

EC trying to get support from Buildit to get washers and supplies to help community fix the leaks...(Agency)

Outcomes

Outcomes in Dec 2015 blockages started to decline...(outcome – intended outcome – program activity) Jan 2016 only 1 blockage. Need to get Ayanda presentation.

Midmar is clean

Site for miniSASS past 6 months did not touch the water at this point because the water quality was so bad and smelly...(context) But on 26 Jan we saw a crab and that is a good sign we were all amazed...(outcome – intended outcome - program)

Person from Dep WS comes out to see the manholes ..(outcome – emergent)

Insights

Get close and local

Need tools to help us to understand was is going on.

EC are more passionate about the environment

“To be honest with enciro-champs started some of the enviro-champs were coming for the 200 rand for airtime...(motivation) but as they were involved they became more passionate about the environment...(mechanism heightened interest + outcome.. intended + emergent).” says Ayanda

When there was no funding there were no reports...(outcome..emergent) – community commitment? How is government supporting the continuity.... Even when there was no funding the ECs continued to work but were not able to collect the data...(outcome... emergent) There was

a break between funding continued to call the plumbers. Govt very much behind the project – everyday job for 20 people.

Thandanani getting up to speak we introduced as the – this is the left hand of liz and the right hand of liz.

Public event with the drama

Eco Clubs made it easier to get into the school.

You are the man of the toilet now... (relations – cultural).

The actors are seen in the community and resulted in conversations going on throughout the community in many different settings. Eg children walking to church point out the actors...(cultural)

Need to consider the legal framework for Community of Catchment management Forums. Etc and how these kinds of groups can contribute into water management processes.

Report back – “For the project to be sustainable we need to get people’s buy in. It is better if it is initiated by them rather than you going to the community and saying that we invite you to start a project. So that they have a sense of ownership and will sustain the project. (Report back on group work at the international Cit Sc workshop)....(agency)

Interview with Tanadanani and Ayanda with Morakane

Ayanda – background

The reason involved – introduced by friend who was an envirochamps...(existence of recruitment network) started with one manhole then became very involved. 6 months later appointed as the co-ordinator of the Enviro Champs...(amount of knowledge + outcome)

From 2013 facilitator of Kids Clubs with Louine B using the citizen science tool...(outcome – individual development). I had more information and knowledge started to organize my own trips...(outcome – amount knowledge – individual development). The tools were very useful to me. Have been doing to the miniSASS were the kids – saw that the scores were getting worse and worse....(outcome – program activity) Found manhole that had been discharging for a long time...(outcome – emerging – group). Using the miniSASS helped us a lot and when we sent the data to the Dept of W and S. Did miniSASS above and below the spillage. Detp of WS got involved. We got a chance to speak to the minister of WS and got a chance to tell what the our project is all about and the challenges we were facing (outcome – collective – evidence -). 2012 started spilling started to get fixed in June last year after we meet the minister...(existence of something – relations – agency - + outcome) Min has relationship with the people we were working with in Durban. Phoned on Frida and the pipes arrived on Monday. Before we met the minister we

Npoelwo and Siyabonga – met in 2014 when they came to MP to launch Adopt a River -0 they were aware of EC and wanted to employ EC to clean the river because they have some training and understand why they are picking up litter EC had that background information...(outcome – program activity)

Before we only had a relationship with the local municipality but they only had responsibility for waste. UMDM had responsibility for water and waste water...(existence of something – resource – structural) Divisions of labour.

Thandanani

New and old envirochamps – I am an old envirochamp. Introduced to DUCT by Mdu Mchunu. Was working with Mdu on groups of men. Also worked with TAC – HIV AIDS..(Tandanani context – how he was introduced to EC – Role , resources he brought to the EC)

Liz Taylor connected Thandanani about working with the water and sanitation issues. Liz asked what T thought T could do. T thought drama. Worked with Liz to develop the drama in the community. Later became an EC...(knowledge + resource that Tandanani brought became part of the program activity --- then it became his responsibility)

Cit science tools– not expensive, not expensive, friendly for the kids, Kits were helping us a lot to see what the problems are ...(intended outcome – program activity – tools interactive)

Had meeting with the engineers from Durban and the district municipality – tools were very important...(outcome – program activity).

If you were a white person coming into the community they did not want to know you because you were coming from the opposition party. Till to day I ask myself why. We have a network with the local municipality so we forced them not work with the whites but it was taking a long time...(context of Mpophomeni community)+ outcome)

Why am I still in DUCT – I need to see the change where I am living. If I do not do it in my community then who will do it?... (individual agency – belief + reason + role/responsibility)... (intended outcome of program activity...the basis of citizen science practice)

Ayanda

I am passionate about the Env and also I am a student (2nd year ...) my assignments and exams are easy because I have been doing it through EC...(individual agency – reason + individual emergent outcome – motivational response)

If you take the EC away (the people are central to making it work)... (context + existence of something = social capital + structural/cultural) The R200 airtime money is very important...(program activity + mechanism – motivation). Training they got reimbursement – the money is important to making the project go forward...(context + program activity) When we had no funding we could not get the data even though the EC continued to report...(should form the fundamental of the program activity) If the funding did not get money the EC would go to get a job

(economic limitations = outcome + unintended for both the individual, group and the CSO.... + relations – power)

Thandanani

To me I don't like to think about it as a stipend – but need to get reimbursement...(context of Thandanani – cognitive and economic value to the stipend + mechanism existence of money)

If you get support from somebody that is the most important thing. Some funding to socialize – to go see the Rhino or to see the Maluti Drakensberg. Through the small funding for the outings and training..(emergent outcome + program activity). The information was a very important – it is very bad to have the information but not be able to disseminate it..(psychological + agency Individual agency)

DUCT was not in control of the project in Mp the people who are in control of the project in Mp were the people in Mp so that's make ECs stay in DUCT because we sit together to plan the project to take the project forward... (collective agency + cultural/ beliefs/reason ----- this becomes a structural/cultural activity)

Ayanda

EC have attended accredited training.(program activity later stage) Some ECs have children ..(relations – family responsibility transcend to social responsibility) and now they are able to help the children with the homework which is more important..(outcome of the program activity). They are getting power because they have more knowledge...(outcome of program activity of accredited training + this then become a mechanism of reason for individual and collective agency) One of the reasons that they ECs stay... (emergent outcome for sustainability)

Ayanda – by attending the accredit courses at WESSA (program activity later stage) has helped me to get part time job at Umgeni Water as a water process controller...(outcome – mechanism = structural/role + relations/responsibility) Have also attended workshop with international people (program activity – emergent outcome of the program + existence of something = exposure to international people) so it has improved my life..(emergent outcome – individual – sense of belonging or sense of value).

Thandanani

ECs have change my life.. (emergent outcome – individual – cognitive realization = mechanism) because I have some course but I am not accredited for the environment. The small stipends help for sustain my life..(existence of a structural resource + family/livelihood). The network (program emergent outcome) I made with DUCT is working for me (relations – responsibility + individual agency). I do sme street theatre and after that I get something (emergent outcome – individual). I need to survive. (context of CS practice basis + outcome/mechanism – individual agency)

Ayanda: miniSASS was introduced through the Eco Schools then the ECs started using it (context – introduction of the tools) and it has been helpful for testing the water quality (program activity).

Because of the CS was helping some of the members who were thinking the environment was a big thing. (intended program outcome – psychological transformation) But it is not a big thing it is something we live in. The GPS was also important – there is something happening in Mp that is making our river and our dam dirty for the future. That is why we stay in ECs. (intended program outcome – awareness of the surrounding)

Ayanda: When we did not have the internet connect we had so much data but people could not see what we were doing because we could not upload it... (mechanism – existence of resource)

People not working in Mp and many of the children are orphans. They really need a meal and they will never forget you... (outcome – relations/responsibility + both individual and collective agency/belief)

The money (existence of capital) is a recognition of the work that we are doing (emergent outcome)

In KZN you can't do anything without going to the war rooms. (political context) There is a structure that Zweli Mkize set up. In Umgungundlovu district it is one of the successes. In the war rooms you need to talk about the challenges you have in the ward. You have got super people who were telling us about what you are doing with the door-to-door. We are mixing the old EC and new Champs to go to the war room to report. (existence of structural resource for reporting and making your voice heard)

Liz Joins the group

How important are the networks and the ability to use the networks (program activity).

Liz

In the early days when we would invite Spu Kiswayo we would write a long list of organisations to join. Local municipality, district municipality, midlands meander, NGOs from Mp and NGOs from beyond, invite councilors, plumbers, DUCT, - go through very carefully people + existence of structural network)

Discovered quite soon that Mp has lots of people involved. Mp is a vibrant place with many clubs, churches, etc. In each of those organizations there are always people who stand up and are community champions. (context + existence of cultural relations/responsibilities)

Is EC different from the other community group in MP (context)

Ayanda – it is very similar to other organization in MP currently working with another group (Place of Hope) for the orphans (context). Linking with them to teach the children about the water quality. The env issues and social issues are linked. (existence of structural relations + collective agency/knowledge)

Some of the NGOs in Mp are many years old. Some of them 15 years. Mp has long history of NGOs on the community and so many of the children come through these NGOs and have an affinity to doing community groups. (context + cultural make-up)

Tandanani: You can find these community in other communities even if the issues that they are dealing with are different. (context)

Have there been conflicts around resources/ jealousies.

Tandanani: No there are many projects in MP under waste (number of similar projects existence). The problem is groups work in silos. Authorities do not want to work together. They want to keep the identity of the different projects.(anxiety)

Liz: Need to lift up the pressure a bit – need to put some pressure on the councilors...(program activity). Use the Warrooms meetings you can tell the councilors what is on your mind. Liz has pleaded with the EC to the Warrooms. The sheets have a number of questions related to engagement. (existence of political structure for participation)

Liz: It takes a while and after 1-2 years (the number of times for individuals to gain confidence) they start to feel more confident and able to participate in the warroom meetings.(intended outcome – individual+group))

Thandanani: You need to have a person to introduce to the Warroom. After you have been introduced you can contribute. If you are not recognized you can't do anything. WESSA recognized because of EcoSchools, Door to Door making Duct to be ahead in the community. People who come here schools and international visitors are making us to be recognized (existence of cultural and structural recognition for political participation + context).

Because of the relationship we have with the councilor ECs are given some discretion on who they hire, etc. (context at a later stage)

The councilors have such a bad name for hiring their own people that they are threatened. Councilors now very happy to give the responsibility over to Ayanda. (+ outcome that changed the context)

What is the interest that keeps people involved –

Ayanda – the focus is their street and midmar dam. Whenever we have training days we talk about cycle. In one training Liz mentioned that the we the water cycle. They are keeping the street and midmar dam for themselves and their children.

Do people own their homes

Most people own the house , they have title deed, others they don't own the house (context).

Is ownership a big part.

The RDP houses they are renting the houses and that is where we have the serious problems with illegal dumping and spilling manholes. (context + relation with water)

ECs are mixed some own houses and some don't but all from Mp

The RDP houses are not owned by people who live in Mp. Most of the people living in RDP do not have a care about MP.

People tend to keep their yards clean but outside of the fences and particularly in the illegal dumpsites.

What are the citizen science tools that we need that we do not have yet.

No response from **Ayanda and Thandanani**. Liz talked to the possibility of having a fenced area with a concrete base that is properly managed at strategic points...(mechanism – existence of structure – that is outside of the project but enable the reduction of pollution)

How much do the tools add to what you are doing?

I think the tools aid the ECs. Before we had the tools the ECs were just reporting the manholes. There were not trips with the kids. They empower the ECs with knowledge so they can help the community. (outcome)

How do you feel about researchers coming to your place and doing research.

I don't have a problem. But community members they thinks that you take information from us but why you didn't thank me for my time. There is a sense that people come and use them. Researchers need to be careful and treat people with respect. Particularly need to recognize that people are busy and if extended interviews then need to pay. (context – anxiety around research in MP)

Research needs to contribute to everybody's understanding, rather than just extractive. Should pay to stay in the Mpop tourism experiences.

One thing that I did want to say that I think is a very very very key thing is the funding. I think that that is first and foremost. The fact that we had quite a bit of funding in the beginning, we did not have it dribbling in at the beginning, we weren't on a shoe string in the beginning. We had that big funding from UMDM in the beginning. Everybody got T shirts, we had lunches with food, we had outings, the ECs were able to do 2 plays a month, each got paid r200 per person involved including transport, EcoSchools Leween was there full time in all 8 schools, and she was doing science projects and linking with the ECs. There was training with the Durban theatre groups at UVP. And that lasted for 2 years. It got going – this is really going well. Then the Green Trust funding came and that was very important because it enabled people to go on courses and we had a lot of accredited courses being run and the PMB ECs started. And that was very successful.

Good funding and the funders have been flexible in terms of moving small amounts from one budget line to another. (outcome + mechanism – existence of structures and capital)

Jim Taylor: Would be good to document the courses the ECs have done.

Jim Taylor: Creating a learning society (outcome of the program). If the people don't learn they are not going to grow.

Participant 4 – has been dumped with trying to get ECs going all over PMB...

Councillor

The EC did a lot through the intervention of Liz and the ECs we have had a lot of success. They have programmes and we have programmes and we consolidate our programmes and make one programmes. They are the ones who do great work. (Agency + relation + outcome from the municipality)

If we can even raise the number of these ECs so that they go all over. I even asked Liz if we can do education programmes at schools. What is the importance of the environment. (outcome from the municipality)

Why do you think the ECs have worked well.

The training. The training is very vital. And the communication with our communities. (mechanism – existence of a resource)

They communicate with us as leaders so when we go to meetings we introduce them to the public and schools. The guy from ECs even though they don't come every time but they come to give us their objectives. (mechanism – communication protocol/presence and participation in the wards)

To strengthen? To give them the resources that they need like transport and an office where people can go to contact them... (existence of the platforms or opportunities given in the municipality)

I for myself I have learned a lot from them. (dissemination of knowledge to the municipality + outcome of the program)

The relationship has worked well. It is a pity that I no longer the invitations. When you are having events at WESSA then I am there to help you. Whatever meetings we need we must have. DUCT and the ECs must have more meetings with the communities. (outcome + context)

It may even polute the Midmar Dam. And you know how many people are using the Midmar dam.

All of the councilors are supposed to work with the ECs they are identified in our Wards and we should support them. (motivational response + agency - belief)

All of the councilors were on board at the beginning and Liz should make sure they invite the councilors so that we can be all be involved (motivational response + agency - belief).

I do really go and visit WESSA, what workshops, what do you need.

I don't think I will go back to being a councilor. It is hard work.

If you were trying to set up in another place.

I don't know how possible it is to get the rural areas. There are small streams that people are using to do their washing – we need to teach them to how to look after these streams. (context)

As a councilor you can not do everything. You need a Liz you need these groups to help the community because it is part of service delivery. (existence of resource i.e. EC for the municipality to do work effectively + outcome – agency)

Most important tools.

The drama part of it because it attracts a lot of people. Put more information in it and target the schools. The drama part of it is very good. It is what people can see. But it needs funding (outcome of the program + mechanism for dissemination of information)

Big changes that EC have brought about – it is the unblocking of the sewer pipes. (outcome of the initial program activity)

Why did the district get involved – none of the sewers are leaking – the issue of funding is a big issue. District is doing really well.

None of the sewers are leaking the issue of funding is a big issues especially at the municipal level. They might want to do everything but if they have the limited amount of funds they cant. But the district is doing very well with the littely they have, When you phone them they just respond immediately. They are there at the meetings everytime. (context of the municipality)

They have always been doing it. It was just an issue of funding. I think they have changed their strategy of doing their job. Like proper supervision once they got all of these complaints.

For changing Mp to a better township we need to wrk together and communicate. Identify all those things that are bringining down our community and having a mechanism for dealing with all these things. People want to go in numbers when is there information and to capacitate them. (context from the municipality)

Getting involved with the leadership of the municipalities. We are the ECs we need support. I think the most import part of it is communication. Bring on board the municipal officials. Tell them what we are doing, tell them what we need. If you come forward then it will help. ECs have helped a lot with this communication.(context of the municipality)

I sometimes give a slot to the ECs in a public meeting. (mechanism – existence of a platform to participate)

Xholipo Zondo

Started 2011 so been a champ 6 years Ward 8. St Ndlovu is Ward councilor

Dumping site is not far from me. There is illegal dumping as an Enviro Champ I try to stop these things. (individual agency + relation – responsibility because of the structural role)

People don't know what to put in the toilet. So we do door to door. (mechanism – existence of resource + outcome)

All the things that go into Mtinzima stream and then it goes into Midmar dam.

We have a youth club at the preschool so each Friday we do activities. Then Sat we have Kids Clubs. We bring the Enviro Clubs we walk along the rivers and we see the things that are happening. (existence of resource + emergent outcome of program)

On Sunday I took a walk and saw a dead goat that had been dumped in the river. So on Monday I have a small talk with my friends and we dig a hole and put the goat in the hole and cover it. (emergent outcome + individual agency – heightened interest and knowledge – choice made)

You never live without water so if you pollute then what will the people do. Especially the pregnant women it is a risk. (individual agency + structural and cultural role in the community and belief + relations – feeling of social responsibility)

Lots of talk about recycling.

I like to see my community change. (individual agency)

Door to Door.

Every Tuesday the ECs meet and it is a chance to share how the work is going.

We talk to the councilor. They already know about environment. Even the Ward Councillor when I go for a walk I see the Ward councilor and talk to them about the dumping. (ability to chat to the political official)

I am part of EPWP and I volunteer for the environment.

Plumber Nash

Your interaction with EC

We are working with the guys and these guys are very important because when there is a blockage they inform us and we can deal with them because there are lots of blockages in Mp. That makes the water dirty.

Some people putting a lot of things in the toilets and this causes blockages. EC when they see a blockage they call me and take photos when we get the blockage out so they can see what is causing the blockage. Goat skins towels ...(intended outcome of the initial program)

We had a shortage of staff and EC were helping a lot by going door to door. (+ mechanism – enable the municipality to be effective)

Are there more staff – We need more plumbers but we have an assistant now. Maybe in the future we will find some more plumbers. There are 3 plumbers in Mp but we need 5. We need 2-3 guys to do the sewers and 2 people to do the leaks. Don't know why UMDM is delaying. But we have good support.

The pipes are too small. 110 mm is too small need 120mm pipes.

The community need to be reminded over and over. The EC are reminding them. (enable the municipality to do their work better)

Door to Door is the best way to make a change. To reach each and every person so they understand. (secondary mechanism that works for plumbers)

There is lots of pressure coming with the elections.

Just now we did not even get a uniform. I don't know where the money is going. They are giving us a problem. (context + anxiety)

If the ECs don't call you. ECs call us and save us petrol and time because they tell us which manholes are leaking. (mechanism – EC become vehicle for offloading work from plumbers)

Midmar is starting to be clean. The river is much cleaner. (intended outcome of the program)

Impendle are using outside toilets so the problem is here is the flushing toilet.

Group interview with ECs

Baba Cele

ECs is a good thing people starting to change their attitude toward the environment. Even the new ECs are adapting to the way that we are doing things. People starting to respond to solid waste and manhole spillage. People will come up to us and tell us if the manhole is spilling. Something good is coming. (outcome – dissemination of information + psychological change)
Some take it as if we are just wasting time. But most even my neighbours know me that I am an EC and that we are doing this for nothing we were doing it voluntarily.

(Wanted MP to look neat and nice like it was a long time ago. (individual agency – motivation for volunteering)

It is a good thing to be an EC because we can pass on knowledge to the young ones. They are happy to do a walk and to do miniSASS. Even the old ones are willing to volunteer as they know

there are other ECs working. They know we have changed children in our community. (collective agency + intended outcome of the program + relations shared responsibility)

Baba Cele, participant 1, 2, 3

The way liz taylor taught us to do this. She says we should be humble. Even if we see it is too much you should could always come down. It helped us. People in a meeting tell us, some of them insult us, we are not politically, try always to be nice. That is the key that always helped us. If somebody attacks you and you retaliate then everything will just go bad. (context – condition in which EC work in)

I think that communicating with people individually. We give them pamphlets. (mechanism for dessiminating information)

10 minutes for each house sometimes more and people chat about their children. We take pictures. Of things like leaks. Then Nash and the plumbers fix them. (mechanism for dessiminating information)

We are familiar with the plumbers and when we move around on door to door and we call them and they come immediately..(outcome + mechanism – relations – power). Before we ECs started the community would have to go and report it to the office it would take days, weeks, months and even years. Some people said that the leaks have been there for 2 years. Now we call the plumbers and they come and solve the problem. It has really helped us. (intended outcome for the initial program)

D2D – we have a format that we use to structure the meetings

We have a voluntary team who volunteer to fix inside peoples houses. We don't have tools so we share them to go and do that. Sometimes you find an old lady who does not have money. (show of care + motivation for volunteering) Sometiems it is a washer so we buy it and fix it. The people start to realise now that they are interested in becoming ECs because they see the things we are doing. (outcome of the initial program)

When we presnt at the war room one of the SASSA emmployee was so interested. Because you are doing d2d we are having a problem with the old granies who stay with the children and they are not getting the money. Please can you see if you can help SASSA by reporting such things. (context + expectations from the researchers)

It helps everybody in the community...(intended outcome)

Drama – did in the community and at the school.

We teach them about healthy food. (emergent outcome)

No clean water running down the street, no more spilling manholes, solid waste (outcome of the initial program)

Dealing with in same ways – taking GPS coordinates, reporting, putting onto spreadsheets.

If Ward 8 has a war room meeting for instance we would go before and after and sometimes go to the meetings.

Asked person not to dump because the truck was coming but she went to dump so took a photo and then Baba Cele went to talk to her and she was very sorry..(emergent outcome + individual agency).

Adopt a River we used to collect all the rubbish in the black plastic bags and then the municipality does not come to collect then the goats and dogs spread all the rubbish.

Whenever asked about how to make env champs better very little ideas. It sometimes requires outside stimulation to generate new ideas.

Baba Cele stressed the use of the phones. Also the need to get a camera to take good pics. Need smart phones with cameras (mechanisms)

Door to door took a petition and got it signed and then took it to the umgeni municipality to tell that we are not happy. Liz helped me to draw it up. (existence of a resource to formally participate in the political platform)

Appendix 9: Dates and times suggested for the school visits

Name of School	Participants	Date	Time	Contact details
Primary School 1				Ps1@gmail.com
Vereeniging	Educator 1	30 August 2016	10:30am – 10:45am	
	Educator 2	30 August 2016	11:00am – 11:30am	
Primary School 2				Ps2@gmail.com
Sebokeng	Educator 1	31 August 2016	10:30am – 10:45am	
	Educator 2	31 August 2016	11:00am – 11:30am	
Primary School 3				Ps3@gmail.com
Sebokeng	Educator 1	01 September 2016	10:30am – 10:45am	
	Educator 2	01 September 2016	11:00am – 11:30am	
Primary School 4				Ps4@webmail.co.za
Evaton	Educator 1	02 September 2016	10:30am – 10:45am	
	Educator 2	02 September 2016	11:00am – 11:30am	
Primary School 5				Ps5@gmail.com
Evaton	Educator 1	05 September 2016	10:30am – 10:45am	
	Educator 2	05 September 2016	11:00am – 11:30am	

Primary School 6	Educator 1	13 September 2016	10:00am – 10:30am	Ps6@gmail.com
Evaton	Educator 2	13 September 2016	10:30am – 10:45am	
	Educator 2	13 September 2016	11:00am – 11:30am	

Appendix 10: Rhodes University Education Faculty Ethics Committee - Ethics Approval Application for PhD Thesis

**EDUCATION FACULTY ETHICS COMMITTEE (EFEC)
ETHICS APPROVAL APPLICATION FOR
PhD THESES**

TITLE OF RESEARCH: Evaluation of the uptake and use of the citizen science tools for the improvement of the water quality resource management: Case studies in the Umngeni and Emfuleni municipalities, South Africa.

DEPARTMENT: Education

DATE: November 2017

RESEARCHER AND STUDENT NUMBER: Ms Morakane Madiba (13M8175)

SUPERVISOR: Prof Heila Lotz-Sisitka

IMPORTANT: The following form needs to be completed by the researcher and submitted with their research proposal to the Education Higher Degrees Committee. The details to which this form relates should also be evident in the text of the proposal. You must read the Faculty of Education Ethical Guidelines for Educational Research *prior* to completing this form.

Level of thesis (please tick)

MEd – half thesis	MEd – full thesis	PhD
		X

Funding (please tick)

Self-funded	Funded
	Please specify:
	X NRF

Ethics protocol code (please tick)

	YES	NO	N/A
Research ON children		X	

The research requires direct engagement with minors (as defined by the Health Act) This requires EFEC and RUESC approval			
Therapeutic Research that includes interventions that may hold out the prospect of direct health-related benefit for the participant.		X	
Non-therapeutic Research that includes interventions that will not hold out the prospect of direct health-related benefit for the participant but may produce results that contribute to generalizable knowledge. In the event that this research involves minors it requires ministerial approval		X	
Research WITH children The research requires limited engagement with minors. This would include having minors as research participants but the research would not be about or on them. This only requires EFEC approval (unless the research is classified as high risk as per RU ethics handbook)		X	
Research ABOUT children The research requires indirect engagement with minors. This would include reviewing information about minors from documents and school files. This only requires EFEC approval (unless the research is classified as high risk as per RU ethics handbook)		X	
Research with adults The research requires engagement with humans other than minors, such as teachers, education officials This only requires EFEC approval (unless the research is classified as high risk as per RU ethics handbook)	X		

Please indicate below how the research supports the indicated ethical principle of:

In the proposal I mentioned that I have generated a vast of data from the pilot study on the citizen sciences projects with GroundTruth for the pre-doctoral and contextual profiling phase. The understanding with GroundTruth was that the data as part of document analysis will inform my PhD study.

Hence the ethical considerations that are going to be upheld throughout the study will respect ethics and values of GroundTruth and their relationships with the participants, and will also comply with the principles alluded in the Rhodes University Ethics Handbook, as well as respecting the values and morals/ethics of the participants governing their independence and dignity. Therefore each of them will require some type of ethical etiquette. Even so it might still be difficult to make ethical choices especially that they need to be applied at the same time. It becomes even more complex when their ethics are administered between religious principles, morality and law (Bonde *et al*, 2013).

To minimise the contradictions this study will look at the layers of ethics that respond to; 1) the justification and nature of what is good and bad, 2) the social standard and principles of what is good and bad and 3) actual application of what is good or bad at the time of interaction (ibid). All these layers are concerned about the implications of actions to an individual or a collective and sometimes in reality it is difficult to set boundaries that are fair and communally benefitting.

Nevertheless what is important is to ensure that the interests and dignity of those who are participating in the study are not harmed or belittled. Table 1 shows the kind of methods used to collect data in the two case study sites, the Mpophomeni enviro-champ and the Vaal primary school teachers.

1. Respect and dignity

Respect in this study is highly thought through. It is not only about respecting and preserving the dignity of the participants or the institutions involved but also respecting the participants' wishes on how they would like the data be represented to preserve their dignity and knowledge.

Moreover the participants knowledge and perspectives will not only be acknowledged but also making them form integral part of the research and its planning.

I intend to be considerate, sensitive and careful on how I will approach the participants for gaining access, permission to participation, protection of identities, consent forms, expectations, and transparency of sharing information. Respect goes a long way because it strengthens the integrity

of the study. Anney (2014) explains that one way to achieve the integrity the researcher must *develop an early familiarity with the culture of participating organisations and participants; ensuring honesty and transparency to the participants; allow iterative questionings; allow reflexive interrogations and do member checkings.*

Lastly, on every occasion I will ask permission to record interviews, record focus group and workshop discussions, and to take photographs or other visual data (e.g. video recording of the discussions and of citizen science tool training/ application session observations – if possible).

2. Transparency and honesty

Disclosure, allowing access to data analysis and interpretation, as well as sharing them with the participants will be used as another way of demonstrating honesty and being transparent. This process though is not easy as it sounds because making a judgement on when [e.g. degree of completeness] to share or how much of the data should be shared or how it should be shared for the participants to interrogate it, can be tricky (Turilli & Floridi, 2009). I however intend to minimize this dilemma by judging how the information I am intending to share will help the participants or decision makers to make a decision about a particular issue. Again another way of minimizing the confusion is by allowing to hear the voices of the participants about what information could be useful and when for them to make particular decisions. This also form part of iterative questionings and member checkings mentioned earlier as ways of ensuring that the information and knowledge are deliberated accordingly.

3. Accountability and responsibility

Accountability and responsibility are used interchangeably in this study and they refer to the fair obligations that I have as a researcher for the participants and institutions in the research process of this study. The role that I will play is to share how I will balance and explore the meanings of my interpretation of the data with those of the participants. These can be achieved through iterative conversations via semi-structured interviews and workshops, as well as consulting with the key informants of the study which I intend to interview later after or during the first phase of data analysis should the data acquired from GroundTruth be insufficient for elaborating the Context-Mechanism-Outcome configurations and the programme theory.

4. Integrity, academic professionalism and researcher positionality

Since I anticipate to do a follow-up interviews with 6-8 informants after the first phase of analysis. Ethical clearance was obtained with Ground Truth for the first phase of data collection. I will then undertake new ethical clearance procedures for additional data, and will also obtain ethical permission from GroundTruth to use reports on the citizen sciences project that have been

produced by the project since the research started. These will be treated as documents for analysis.

Since the study is going to be conducted by me, as a researcher, who is an individual having independent ways of doing things and also influenced by my own ethics and morals. It is important to be reflexive about the self and continue to negotiate the balance thereof by regularly communicating my challenges with those involved throughout the study.

Another challenging aspects about my positionality as a researcher is that I worked for GroundTruth which to some extent has a positivism view about the uptake and use of the citizen science tools for water resource management. At the same time I am a critical realist, evaluator, academic researcher and have built a good relationship with the participants and the institutions involved. So balancing those perspectives fairly might be difficult.

After all, what is important is to ensure that the findings of this study are communicated clearly to the participants, citizen science tools developers and the decision-makers of the water quality monitoring.

5. How many participants will participate in this research?

There will be additional 6-8 informants for semi-structured interviews in addition to the documents going to be acquired from GroundTruth and the workshop.

6. What are the selection criteria for selecting the participants?

Once I have identified the key CMO configurations in the initial data and I find out that the data is insufficient, then the missing data will determine how and who to select for further questioning. However the informants have to be involved and have in depth knowledge of the uptake and use of citizen science tools.

7. What is the rationale behind selecting these numbers of participants?

In the initial data there were many informants from diverse contexts, selecting 6-8 key informants is with the hope that they can represent those contexts if they are not covered fully. They are to deepen the initial data collected during the GroundTruth citizen science project with Water Research Commission.

8. How will confidentiality and anonymity of the participants be ensured?

Being involved with communities and individuals of such different background, position and roles, the content and context of information in the letters to request for permission to conduct the study will be different but linked by the research question. Again, tension between rules, ethics

and morals might arise, however I intend to minimise them by clearly explaining and discussing the research purpose, explain the terms/conditions of voluntary participation, confidentiality, and informed consent for willingness to participate. In terms of handling anonymity and privacy to participate, I intend to show the participants the list of people who are going to be involved in the study whom their names will be known to. This is because this study is about both individual and collective learning. Nevertheless by virtue of later having workshops where focus groups are possible, either way the exposure to one another's names or roles is inevitable.

9. How, and for how long will security of data be ensured?

I intend to keep data secured for about 5 years as documents in a hard copy and soft copy, as well as keeping them in a form of transcripts and voice recordings. These will be saved in my email cloud memory, external hard drive as well as giving them to GroundTruth for future reference.

Please provide copies of the following research instruments:

Please see Appendices 1-6 below for the following:-

- Interview schedule
- Pictures showing the type of citizen science tools investigated in the study
- Questionnaire/survey
- A sample of request letter for participation and a consent form
- Email letters suggesting the times and dates on when your schools are going to be visited.
- Dates and times suggested by the teachers and principals for school visits.
- Questionnaire sent to the attendees of the February 2016 Citizen science workshop.

Signature (Researcher):

Signature (Supervisor):

Date: 21 November 2017

Place: Johannesburg

Appendix 11: Example of transcripts with different versions indicating different stages of analysis.

One version has raw text verbatim in vernacular, and the other in the form of notes, extracting only important information. Colour coding represents the type of mechanism, context or outcome.

Key:

Number of times

Existence of something (structural)

Psychological, cognitive, Affection, Physiological, Economic, Sociological, economic, Sociological, organizational process

- Amount of knowledge
- Hightened interest
- Motivations
- Anxiety
- Motivational responses
- Choices made

Programme activity

Outcome

Context

Challenge with the workshops

School 1

KEY: Researcher (R)

Teacher 1 (M)

R: what were you teaching?

M: By then

R: yes

M: I can't remember, it was NS, I think yes. It was Natural Sciences

R: okay, grade?

M: I was teaching NS grade 6, so I think that's why they took me, at that time I think mam was an HOD, so I don't know at what capacity did they take her, I actually don't remember.

R: okay, so who introduced you guys to the project?

M: I think we got it through the district and I was selected as one of the people that would partake in the workshop to represent the school.

R: and then how did you become involved?

M: How did I become involved?

R: ee and why?

M: uhmmm. A some point, the problem that we have in school is that at some point you find that there was a relevant person that was supposed to go there ebe ele gore gaa kgone. You might find that se ba lata wena and say that you must represent the school. That's why I am saying that the workshop, I cant even remember gore it was based on what grade or anything of that sort. That's why I am saying I was a little bit lost.

R: Mara were you told in advance what the workshop was about?

M: Yah, bona baile ba re jwetsa gore it was in terms of environmental awareness. But basically ne re le on the water.

R: Do you still remember gore workshop ya teng ne ele eng and ka eng so?

M: yah, I think it was around water, how we supposed to save water. Teaching learners how to care for water. Yes we also went to the river. What were we looking at? I think we were looking at animals inside the water (minisass activity)

R: and then what was your expectation when you went there?

M: at some point when you go to the workshop, sometimes you go there without having any expectatations, but immediately after they analyse the workshop gore its all about this and that. You then start to have expectations. Maybe I might pick up something that I might use or is relevant. They were talking about the importance of water. I still remember that day when we were analysing the importance of water, somebody sent me a message gore sekolo se tswile because there is no water. I even shared that with them saying, if there is no water, everything comes to a standstill.

R: what was the water situation then?

M: I am not sure whether it was a shortage or they were cleaning. Sometimes you might find that maybe the pipe blasted somewhere, because there was a question of the pipe because it did not happen in the school premises but close to our area, I am not really sure what and where it happened because I was not around, but from what I heard it was a pipe burst in some nearby area.

R: were you experiencing the water situation at your school around that time?

M: Yes we had some water situations

R: Tse jwang so? What kind? Was it water quality or?

M: so what happens here is that sometimes you come to school and you find out that there is no water. At some point you find that during the course of the day they shut off the water pipes. I am not sure if ke tsela ya go saver water, I don't know.

R: oh so batswala metsi, ke bo mang?

M: maybe it's the municipality because communities cannot have such powers, we don't even have an idea gore where do you close water-pipes. Sometimes when there is a renovation around, they might close the water.

R: so the problem then ne ele gore ba tswala metsi and you wouldn't find the reasons gore why?

M: yah that was the problem because sometimes they don't communicate to us, you have to go to the radio if you are going to close the water, give people the reason why. So the situation was really bad back then, every now and then they close water, they open it in the afternoon and so on. But now of late it has been very scarce mara who knows it might start anytime cause keile ka utlwa gore there is a shortage of water.

R: Do you think the community around here is aware of the water situation?

M: people are aware, I think they are aware. As I am saying even this week I had the media saying we are at about 34% of water in the Vaal, so yesterday I communicated with some of my co-workers that at some point we teach kids about the water shortage. The principal tried to warn kids that on the 1st of September normally they play with water but I got that complain even yesterday I think during the last periods. Kids ne ba tshelana ka metsi around. Uhhmm the foundation phase, they knock off earlier than us. So I have said that the only solution is to close the taps because it was

already time out for school, so they went home. There was no water. So yah, I think the community is aware, they are also aware of the water shortage.

R: do you think they have changed the behaviour on how to care for water?

M: yes they have changed. Yesterday it was there and there were people ne bantse ba tshelana ka metsi. It was not like all other years. Even our kids we tell them, some of them even send messages at home saying that we have shortage of water.

R: okay, we going back to the workshop now. I don't know if you remember the activities that you did. There was one where they cut a 2 litre coke bottle and put in different sizes of sand and then they filter the water. And there was another one where you went to the river and were given a net to scoop water and then put it in the tray and looked through with the magnifying glass so that you could see. Do you still remember that activity?

M: yes I still do

R: do you still remember what was the purpose?

M: uhh what I can I say. If I still remember the purpose was addressing this idea of clean water, they were showing us that there are minor living organism in the water that you cannot see with your naked eyes from the dam. And the one with filtering was on how water can be cleaned I think that's that.(minisass)

R: Okay, will focus on that one ya microorganisms, what did you learn from it?

M: at some point for me ne ele gore even if we keep that water, the water that we think its dirty. It is not really that dirty because there is a life in that water. That if you pour chemicals or waste in rivers or dams you are also killing some of the living organism in the water.

R: With that knowledge, how did it help you in general after the workshop?

M: generally even us, if I can remember when I came back from the workshop. Uhhh they were trying to say even this water that goes , we have some sort of a dam. In fact the water here goes in the same direction. It can be from Sebokeng, Zone what, our water goes in the same direction, and the it goes to the vaal. The water goes to the Vaal them. Actually they said that is the water that we are drinking, so we must try to make that water as clean as possible. Because at some point we throw quite a number of things at the dam, next to the dam. Whatever it goes to our dam which is our source of water, it is the water that we drink. I thought that the water from the dam was kept

somewhere but they told us that it is the water that we drink. They clean it, so if we pour chemicals into the dam it becomes expensive to purify it.

R: so have you changed your attitude or behaviour since then?

M: in terms of us as professionals there are a lot of things that we don't do, however it is our duty to educate others so that we can share the knowledge and information that we have. That way people can also change their behaviour (individual agency – relations/ responsibility). With our friends we talk hey, not formal like the workshop, its like a meeting of some sort, we tell that we have learnt this and that and maybe somewhere somehow it has helped. (individual agency)

R: So you have integrated that knowledge into your lessons plans?

M: yah yah, it was easy to integrate it because I was teaching Natural Science (existence of a system), although the, it was the information that I shared. We have the learning programme. Some of the things ne se re fitile ho tsona. (timing of the event matters) Sometimes I wish that people that are doing workshop, they can also focus on our programme because that is the problem we are encountering (challenge with the workshops). You will find that this year I am teaching this area, next year its another person. But if they focus on the learning programme go ba easy gore what you learnt from the workshop e kene gantle on what you teaching. Because once o fitile ha e tlo kena haholo, o se o e bua fela, eba something that you just say in passing.

R: So with the knowledge,... are you able to share it with other teachers so that they can also teach learners about it?

M: you know to be honest, go ba easier to say I am from the workshop and this are the things that I have learnt to other teachers. I think at some point it would benefit if go ka etswa rona kaofela. Because I might not present it the same way, some people even if they are teachers they are still introverts, they know things for themselves. Even though we share it might not be with the same energy. Sometimes we present to them in the afternoon and people are tired so they don't really pay that much attention. (Challenge with programme activity)

R: So do you think as the school go na le that support ge o tswa workshopong? Like people engage?

M: e teng mara what I know is people are presenting for the sake of presenting and saying I am from the workshop. I think it also depends on the person gore otlo enka jwang ena. O mongwe you might find gore wa ithoballa, wena o tla bona motho ao shebile kante o ithobaletse or the mind e

kgakala. Uhhh reporting time is also not a good time, motho o exhausted o tswa classing (cultural constraints).

R: do you report all the workshop in the afternoon?

M: yes, there is no way you can report in the morning. We have the staff meeting normally in the afternoon. Even when you present you feel gore people are tired (cultural constraints).

R: So then you said that you used to integrate that knowledge then it stopped, why?

M: from my side the lady o ile a mover to foundation phase. And then I was left here ga ke sa etsa Natural science, im teaching language. The information I can also share with kids that I have. It was nice if it was everybody. With language there is no focus on water, you just touch it in passing, it is not in details. Unlike when you are teaching Natural sciences where it is a content and you have to do it. so otlo intergrate gantle you will do the filtering, you will do all those things. You can even take kids and say let's go to the river and letla le metsi and identify those micro-organisms, but when you move to other learning areas like maths and stuff to be honest you won't have time to do that. And as teacher we have been reshuffled a lot. (cultural constraints)

R: oh is there a problem

M: no, thing is we have this PMS, It's like an appraisal. We were even complaining about it. because watla ko classeng and you identify my weakness and you need to do a follow up. Next year ga otlala im no longer doing the same subject. There is no consistency as such we can't properly monitor things. I also think that the workshop should have also given us enough materials to give to kids such as pamphlets.

R: so do you suggest that in schools teachers should be experts? If you teaching natural sciences you should do that forever, so that when new information comes etla ko wena?

M: yes. That way when new information comes it is just going to build up on what I know. For example now when you talking about WESSA, You can just say re kopa batho ba neng ba ile workshopong, and then I will be going there when I come back I am not gonna use it because I am no longer teaching that area. And ha onka this new one, you need to start afresh. Wa bona so you are not building something. Like le di results tsa rona they dropped ko matric. Teachers are also moving or relocating to other schools ba bona chelate [that pays more money] and then go kena batho ba ba new. And then the standard drops.

R: how would you describe your relation with the people you are working with mo skolong in terms of this water related things?

M: the relation as I am saying lies with the HODs, actually let's say management. Management knows who went for what workshop and what knowledge they acquired from the workshop and they are also aware of the person that might need that knowledge. So they can pair them up. Nna ko ke tswang we had this development programme. We would leave on Friday and come back on Sunday. That way we can learn a lot of things. There we would wake up in the morning then sit together as colleagues that are doing certain learning areas and we share knowledge.

R: So you don't have it anymore?

M: yes, ha re sana le tsone. I don't know gore what went wrong. Because that was the right platform to share information. Then you guys go to break, after a certain period of time go ba le presentation where we used to share things. Management would draw up a programme then will use platform. Now when you sharing in the afternoon at school people are tired. You have seen how this kids get us all worked up. So when you share what you learnt in that afternoon meeting people will be tired, even if they are paying attention, they won't take as much information. (cultural constraints)

R: So from the workshop didn't you get any teaching and learning materials?

M: we have the booklet. Ne ba re file a box, there were booklets and stuff. Unfortunelty ga ke tsebe nka e supela kae.

R: even when you came back you didn't use it?

M: No I have read it. because go ya ka bona they were saying gore we can intergrate it and stuff. But ne e batla nako, ke ntho e eneng ebatla gore o bale. The way re nang le paperwork ka teng mo mosebetsing, you won't get the time. Some of the thing ekete di ka etswa, e sa ba onceoff thing. Ebe process. Like you do a certain thing ka nako e itseng and gobe le ntho tse kgotatsang on the material. If go na le buka tse ngata fela gwa kgotatsa. (cultural constraints)

R: so the materials are somewhere?

M: yhooo I am not even sure gore where are they now, because it has been long. It was in 2013. We change classes.

R: after you went to the workshop, was there any knowledge you used and o ruta bana ka yone?

M: Yah. Gona le engwe ya, I think ke e those moo. Gone go na le some sort of story. We were reading something like a story. Go na le somethings that they used, like a child would read a sentence and then the other child continues. So ka e bona gore e ba etsang, they concentrate and every learner o dula a mametsa and they want to see ma batlo balang teng. Unlike one a bale paragraph until a e fetsa, that way ba bapala. So that method ke e sebedisa haholo because it allows each and every child to take part. (programme outcome)

R: and in terms of that one ya go scooper metsi, before the workshop were you able to explain it?

M: yes we were explaining it, but at some point some of the things motho ne a sa di bone. Concentrating on the small organism that are there you know. It was just like doing, some of the things we used to get from the textbook but we never focused. But I think that now it is easy for us to be broad and identify the micro living organism that are inside the water.

R: wena according to the knowledge that you have acquired regarding the tools that you were using there, how successful were they or the barriers that you encountered?

M: I think the techniques, if ever ne go na le nako e enough or If this thing was needed I could have been very far. Although I am not saying it needs to be monitored but if something e kenya, re nka like it's a pile of work. Sometimes it makes teaching easier, se ke kgona go addressa reading in other ways now. So ke nagana somewhere somehow go na le improvement. Go na le effort tse ke di nkileng. Mara I also forget to say go na le buka, I could have gone back to say agona ntho e nka e tholang to improve. Improvement yona e teng and ke nahana hore if ke ne ke e sebedisitse and went back to the book, I could have been very far. (emerged outcome – individual agency)

R: Is there anything you would like to share with me regarding the workshop, especially the water quality? Something that you feel was necessary but I didn't ask.

M: uhmmm I don't think hona le something e el eng gore ga o so be botse but nna ne ke batla go botsa gore gotla ga gago ene le follow up or is it something you want to do. I doubt this is the first school se o tlileng go sona. Like I wanna if whether other school are using it or? What I am saying is that you guys need to fix the strategy and the support. So there should be some engagement and support, hot lo bana le growth o tla bona. E sa ba ntho e le sa e checking regularly. (the need for the existence of the structure)

R: oh yah before I forget, were you able to take the kids to the river?

M: No like I said ne se re fetile that part on our content, we have a learning programme you know, the way our education system has been designed, we have things that we are supposed to do on a daily basis. Whether ban aba utlwile kapa jang, you don't have to be behind. That's why re na le such a high rate of failure, even when ban aba progressor agona ntho e aba e tsebang because we are pushing this thing. There is no time to add other things or relax.

R; okay thank you.

School 2

Key: Researcher (R)

Participants (P1, P2, P3, P4)

R: Maybe in the meantime le ka bala mona, go bona gore what the project is all about, the follow up ya teng. So the reason why we picked it up this time of the year, is because I am the one that picked it up as well as water research commission. It is now looking at other options of preserving water, and citizens taking over that task or that activity. So because gona janong re la problem ya metsi and stuff. So that is the reason why, gone yanong eba so pivotal e ba so important to pick it up. Wa e bona.

P1: ee

R: So the questions tse re tlo di botsang, it not necessarily gore you have to remember everything details to details, 2013 is a very long time.

(all participants agree)

R: So now the question that I am going to ask, every basic thing that you remember is enough for me to continue with the work. But also if you remember the details please feel free to add. So maybe in the mean time you all can read here and from there sign here (researcher provides information sheet and consent form to participants and they sign).

(all participants sign the consent form and ask the researcher for clarity prior continuing with the group interview)

R: Ga se gore gotlo ba difficult or complicated, we are just looking at what is currently working, what didn't work, things like that. So that we can be able to improve the next workshop, if we are going to have another workshop regarding water issues.

P1: I think batho ba workshop said ... that ba tlo tla every year and since 2013 ga ba so tle gape.

R: And project ya fela ka 2014?

(researcher reads the information sheet to participants)

R: The main aim of the study is to get what is working for who and how. As you are all aware that in the previous workshop there were different teachers from different school and in different areas. So we are doing this so that when we have another workshop we ensure that it is efficient and specific to particular kind of people.

P1: Ha ne re tswa workshopong, ne ba re file box, and shortly after the workshop ne go na le burglary mo skolong, ba tseya dilo. Le yone box eo reneng re e thotse ko workshopong ba e tsere. Ka mohlomongwe ba ne ba nahana hore maybe ke dibuka ka mo hare or something else. Because batho ba ba keneletse ba thubile di classing, ba thuba le di store room. A soka re etsa anything ka ntho tse ne le ka gare ga le box. And then ntho engwe e baneng ba re kopile yone ko workshopong, ne ba itse ha re fihla sekolong re boloke metsi. Ba ile ba re ruta system ee ya toilet, ba re botsa gore metsi a sebediswa jwang. Ke ho jwetsa tse ke di hopolang.

R: ee

P1: Ha re kenya stena ka moo, metsi a imelwa ke stena, ha hotswe metsi a mangata , abe asa tsamaye hantle, ne re ruta le bana hore ha ba etsa number 1, one flush. He ba etsa number two ba etse full flush. Hape engwe ka di classing hore ban aba seka ba senya metsi . Bana baya kantle ba tse re reke di emere bana ba hlapa matsoho. Kore di emere tseo engwe enne ya ho hlapa matsoho. Wabona e ere kileng ra nna le bothata le yona, mara ka foundation phase rene re sena bothata le yone neh?

P2: ee foundation phase ene e sena bothata

P1: ke a hopola hore ba ne ba reka di emere ho thibela bana ba banyane, watseba ban aba jwang le metsi, especially ba foundation phase, ha ba tshameka kantle ba senya metsi. Fela ka thuso le supervision ne re zama ho ba monitor, ka hore mam ne a ba sheba hore na ha ba tshameke ka metsi, ba a sebedisatsa ho hlapa matsoho (individual agency)

R: And then engwee hape?

P3: E ngwee hape ene ele ya di pompo. Ne ba rata ho tseba ha holol hore pompo tsa rona ke tse jwang. Lucky enough rona pompo tsa rona ke tse tsa cement, so le ha ele hore ba senya metsi bana

neng neng ba e bulele from there ba e tgoele e speita nyana metsi. But for rona because ne re tswa workshopong ya how to save water, ne re ba blella hore its importantto save water. Ne re dula re ba shebile ka gore, otlala fitlhela gore nako tse dingwe ha ba hlapa matsogo ba bulela metsi and ba hlapa ntse ba shebile kwa le kwa so ne re ba jwetsa hore hee tswala pompo.o ska sia pompo o e butse, o ska etsa eng kapa eng.

R: So if le hopola hantle who introduced you guys to the workshop? Le ile yang? Ko workshopong?

P4: Ke facilitator ya rona kamo, Thabang Letlhake, ke ene who introduced us, mara ha asa leyo mo d8 se ale ko d7.

R: so how did he introduce you to the project? O ne o ruta eng by then? And why did they choose you?

P2: life skills

P3: social science

P4: life skills

R: why did they choose you guys specifically?

P3: Ne ba re hlopetseng, I think its because ba ile batla le map wabona, wa bona map ntho ya metsi. So nna they choose me because ntho tsa metsi ne di le related to social science, because social science re bua ka dinoka wa bona.

R: and lona mo life skills?

P2: Ho na le moo ba bua ka how to save water. Lets say hao hlapa, bath enka metsi a mangata, close to 90l and shower yone enka only 11l. ho na le mo re rutang ban akas ho saver metsi mo life skills.

R: mhmhm so ne le ruta grade mang?

P4: grade 4

P3: grade 4, 5, 6

P2: grade 6

R: but then before the workshop[, ne le na le di issues tsa metsi or? Ke bua ka moskolong?

P4: ee re tla re maybe there were there, and rona ne re sa tsebe hore hon a le tsela tse dingwe tsa ho ka saver metsi. Ho tshwana le di toilet, di toilet tse ngata skolong di a flusher. So ne re sa tsebe hore o ka kenya brick ka mogare and ya etsa hore metsi asa tswa ale mangata a senyeha . ne re sa e tsebe ntho eo.

P3: So re ithutile yone after the workshop

P2: hape ba ile ba re lemosa ka di toilet, akere system ya di toilet setse e changile. Ho na ole ntho ha ke tsebe ka toilet y abo ntate hote e fetogile jwale e saver metsi. Pele bare ne ntse e tsholla metsi. So ntho ee ha e sa leyo system tse di mo skolong, ho baneng ene e senya metsi.

R: mara do you remember, I am interested in two activities that you have done on the workshop. The one ya 2l ya coke. The one where you had to put different sands ka mo gare ga that 2l.

P:oh ke a e hopola, kana ne ba re ke eng?

R: water filter

P2:ohhh yah water filter, re bile ra fitlha ra e etsisa bana mo skolong.

P3: ee lenna ka e hopola, mo gonwe ne re etsa ka di tissue, re e sehile then ra tshela santa, majwe...

P4: Oh ka hopola, ne re batla ho bona hore metsi atla tswa ale jwang

P1: eek a hopola man , ne re sefa metsi

R: and there is another one e eleng gore ba le etsisitse ko nokeng, at the river

P1,P2,P3, P4: oh eya

R: the one ko nokeng where you guys were collecting microorganisms

P1: ee ne re tshwara le ka di net, ka gopola re shebasheba.

R: Do you still remember those two activities? Ee e one ya go geela ene le for eng?

P1,P2,P3, P4: (mumbling trying to recall details of the particular activity)

R: I think maybe there were teaching you guys gore if you see what microorganisms in the water, then it determines whether the water is clean or not.

P2: ba re rutile shem, ke hore se re lebetse hone jwanong. And ntho e ba neng ba re kopa yona ke gore how about re etsa trip nyana. Re nke bana re tsamaye le bona re ba rute but ha hona skolo se

eleng hore se ile sa agreeiya. Ka hore ban aba hon a jwala ba active haholo, ba hyper active. What if re nka bana re ya le bona moo and ba pushana? Le ha re ka nka bana fela ka khompi. Ha se ba pushane and ngwana o mongwe a wela ka mo hare, etlo ba mathata a mang. Re phela nakong e thata hona jwale. Re ile ra e gana le di teacher tse dingwe from other schools. Re a tshaba, re ka se nke bana re ba tlisa moo. Bana ba re bereka ka bona r aba tseba.

R: what else do you guys fear ka goya nokeng beside hore ban aba hyper active? Lona le k aba comfortable in any way if we are just being honest?

(giggles)

P1: rona re tshaba metsi

P4: hee ona re a tshaba shwem

P2&P3: yho oo ae le rona re a tshaba, ebile rona ne re emetse kgakalanyaa. Plus mam haa utlwane le metsi. O ile a dula nyana kgakala because ha a utlwane le metsi oa tshaba.(minisass activity)

P4: tota rona ra tshaba, akere ho na le this thing ya hore metsi ana le noha ya metsi, so rona ra tshaba.(myths)

R: noka e le leng gaufi le yona ke eng?

P3: Ke Vaal river neh?

P1: ee ke Vaal river.

R: So regarding the workshop lona ha le bona ele thusitse ka eng?

P2: ere thusitse ka hore how to save water ka hore re tsibile. Even now le ko ha eke sa user ntho ee ya brick. Le hore re ska user metsi ka horsepipe re sebedise bucket. Le hore re ska nosetsa during the day. Its either o nosetsa bosiho kapa phakela. So ne ntse re ruta bana ka dilo tse, ebile principal ne a kwaletse di pompo. Bana ba nako dingwe le ha oba ruta ha ba utlwe. So ho saver metsi, one a kwetse di pompo hore bana ba ska tshelana ka metsi.

P3: workshop yone it was interesting, mar lwena o tlile kgale tlhe.

R: so information ele ee thotseng ko workshopong e le thusitse jwang, especially with regards to teaching ka mo classing?

P: so like nna ke bua gore I was teaching social sciences and mo social sciences re bua ka dinoka hore o di thola kae le kae and then baile ba kgutla hap emo skolong. So ne ba re file map o mohol, so o ne o bontsha hore dinoka tse di hokae le hokae. So ke tlare maybe ile ya thusa bana ho tseba hore dinoka tseo di kae. For example, maybe ngwana one a tseba hore ho na le orange river fela ne a sa tsebe hore e kae. So map oile wa thusa hore ba kgone ho bona hore dinoka tse di kae.

R: so information ya teng lona le e berekisitse for how long after the workshop

P1: I think for selemo seo fela, ha holoholo before batla. Because ne re sa tshwere mohopolo ole wa hore ba santse bat lo tla and b aka fihla anytime

P4: ka hopola ekete ne ho na le dibuka tse ba neng ba fane ka tsona. They were interesting dibuka tsa teng. Ne re di sebedisa mo classing for bana. And di buka tsa teng ne di re benefita koofela. Ha se hore ne di sebediswa ke nna fela mo lifeskills or mam so social science le bo teacher ba bangwe ne ba kgona ho di sebedisa maybe mo English jwalo jwalo. Tsone re di sebedisitse. Thata jwang before batla gape, ne re batla hore ba bone hore re a di sebedisa (outcome)

R: mara why go le jwalo, like why ne le di sebesisa before ba fitlha and then after ba fetsa gotla e be di sa tlhole di le important mo classing? Re batla nnete fela, so that next time re itse gore what must we do different for sustainability.

P: ke hore bana se re ba jweditse the importance ya metsi, re ba bontshitse gore how to save water, even le map re ba bontshitse di noka and all of that, gore dinoka di fumaneha kae jwalo jwalo. So bana ba setse re ba ratile, ba di tseba dilo tse. Even though e ele gore the following year hotla bana ba ba ntsha, map one ke o sebedisa ne ke o tlogetse ko classing ene ke e ruta ka selemo seo, so selemo se latelang bana ba ke ha ba setse ba sentse map oo, bao foldile ebile o tabohile. Ga ke sana one map oo.

R: So wena hone jwanong do you think knowledge ele ya how to save water and the map ne etla ba botlhokwa?

P: haholo. Especially now ka hore wa bona, le he ese ka jarateng ya skolo. Wa bona hore batho baba nka hosepipe ba nosetse ka yona motshehare, so wa ipotsa hore batho ba na ha ba itse hore ho na le shortage ya metsi. So ntse ele important. Cause ho ne le batho kore ha ke tsebe hore na ha ba bone kapa ba etsa fela, go bona hore metsi a botlhokwa jwang le hore botshelo bo tla ba jwang ho sena metsi.

R: For lona ho important jwang hore lenne le metsi a hlwekileng?

P: ho bo hlokwa hobane metsi, wa bona ho na le mo ke rutang bana ka teng mo social sciences ka di diseases. So teng moo, ke ba jwetsa botlhokwa ba ho nna le metsi a hlwekileng hobaneng metsi a sa siamang a ka ba tsenya malwetsi. Mo social science ho ne le mo ba bontshitseng teng, especially ko mahaeng moo batho ba seng di tap teng. So ba bontshitse ngwana o mongwe a ithusa o mongwe wa ja, so because ha hona di tap tsa hore ngwana yo ntse a ithusa a tlhape matsoho. Ha a fetsa ho ithusa o latela oo jang and ha a fihla o tsenya letsoho le ene wa ja and ola le ene santse atlo kula. Engwe ne ba bontshitse metsi aa tsamayang, o thole gore go na le batho ba ba ithusetsang mo metsing, and go na le batho ba eleng gore ba nwa metsi ao. So batho ba ba nwang metsi a, ba sa apaya kapa ho tshela di chemical bat lo kula hobaneng ba nwa metsi ale jwalo akere. So ho botlhokwa hore pele ba nwa metsi ba a bedise and ba a beye nako hore a loke, hob aba bangwe ba tlabe ba a tshetse di jik.

R: Nna ka re community ya mo ke community e jwang?

P1: Ya kae?

R: Ya mo, around mo skolong. Ke community e jwang?

P2: Ke tla re ke community e jwang, nje ke community ee

P3: o bona fela ka bana teng gore ke community e jwang, ke community esa tsotelleng

R: kana ho tsotella ke ntho e jwang

P3: Ke community e sa kgataleng. Cause ha ne ba kgatala le ban aba bona nkebe ba tseba, ba kgona go arola ntho e ntle ho ntho e mpe. Ba tseba hore ha ba etsa ntho e so ho right kapa jwang. So bana ba etsa ntho tse ba di bonong ka ntlung.

R: So in terms of poverty, do you think hore ho tletse bana kapa batho ba bagolo?

P: community ene ha holoholo ho tletse bana ba banyane, ha e se batho ba ba golo. That is why otlo thola hore ha ngata batho baba mona...

R: Ke age e jwang so?

P: ke bo 20, Kore o ka bona ha o biditse parents meeting. Ke batsadi mara santse ele bana le bona.

R: So in terms of housing ke di RDP house or mekkukhu?

P: Ke di RDP houses.

R: and in terms of mmereko?

P: mmereko, ke community ee otlo fitlhela hore he hote identify bana ba 5 mo classing hore bathole di tlhako le uniform. Then bana ba bas a tholong, batsadi ba bona bat la mo skolong ba botsa gore why bana ba bona ba sa thola uniform. Community ya moo, ke e esa sebetseng.

R: and lifestyle ya bona e jwang?

P: ay... bona ba iphelela nje, ha ke tsebe hore nka e beya jwang

R: Ba na le electricity? And metsi?

P: bana le electricity and ba na le di tap. Yes.

R: And di toilet tsa bona?

P: bona ba na le di toilet tse flushing kante

R: lona le tswa le le ko kae?

P: rona re tswa di zoning. Ka ofela batho ba sebetsang ka mo retswa di zonung. Ka kgolwa ke mam o one fela ya sebetsang moo, ya nnang mo community ee.

R: okay and going back to the workshop, oitse ga le tswa ko workshop ele thusitse ka bana, so ke batla go itse gore naa ka gae ele thusitse jwang?

P: So wa bona rona ka gore ne re ile workshopong ere thusitse. Eng thusitse and e thusitse le bo mam

R: and other teachers? Didn't you report back after the workshop?

P: we did report back, ke nahana hore ne go beditswe meeting, ko stuff room. And yes re tlisitse report kaofela ho principal. Ra mo jwetsa hore workshop e re neng rele ho yona e jwang le jwang. Wa ba bona bae me jwang, ha ntse ba le pompong ba bua ntse ba buletse metsi. So tlamikle re hoeletse hore hee tswala pompo. Ha ho sena motho ya ba hoeletsang ba ka se tswale pompo.

R: so le reportile jwang and kae?

P: ne re reporta stuff kopanong ya rona kaofela. Hore other teacher ba kgone ho botsa dipotsa and ba kgona hore thusa ha ba bona bana ba tshameka ka metsi. Le hore ba stress taba ya botlhokwa jwa metsi and le gore re a bolokela jwang mo di classeng tsa bona.

R: So when you come from the workshop, do you all get the support that you need from the other teachers?

P: support yon era e thola. Ke hore fela ha e kalo kalo. Ke a hopola hore ha re gutla from workshopong, it was like ne ele rona fela re nang le concern ha bana ba tshameka ka metsi.

R: Why go sena support so, especially in terms of the knowledge that you gain from the workshop?

P: Maybe its because ba na le ntho ya gore ke bona ne ba ile workshopong and rona ne re say a dilo tsa ho tshwana le tseo. Hore ke bone ne baile workshong, ke bona ba rutilweng so bona ha ba itse sepe. It was like ke responsibility ya rona ha bana ba senya metsi.

R: So does it mean hore everyone ha aya workshopong wa ikela ene ka bone, ke gore ha a ele sekolo?

P: ke nahana hore hoy aka gore workshop eo ke ee jwang. Ere ke etse example, maybe ha ke ile workshop ya social science. Akere ho na le other teachers ba rutang social science, so ha ke gutla I have to report back to them ke ba bontshe hore ne ke etsa eng, if go na le di pampiri ke etse di copy ke bafe. Sometimes o fitlhela hore they have to assess bana ka some of the information so, so yone ba nna involved. So ke nahana ee, ne ba nahana hore okay re bua ka bohlokwa jwa metsi jwalo jwalo, so ne ba nahana gore bone ba kena jwang.

R: So what do you guys think gore we can do to improve workshop and di tools, like maybe di tools that you guys were using on the river?

P: Kore wa bona ha ba etsa workshop ba hlopa maybe only two teachers, so if ele jwalo e ka se sebetsa ho le hokalo. Also ka tseba hore ho ka se kgonahale hore di teacher tsohle di attend workshop. More especially if the workshop ene e tsherwe ka nako ya sekolo. So if hontse hoy batho ba two ha ke bone eka sebetsa hantle.(recommendation)

R: Ne le ratile hore ho ye b aba kae?

P: e thata hore motho aka bua hore ho batleha batho ba bakae hobang ba etsa le dikolo tse dingwe.

R: So ka di holidays ho jwang?

P: mokgatlo wa rona ka di holidays o bogale hampe ho re re ka attenda di workshop ka di holidays even if ne re batlile hoy. Mokgatlo wa rona ha o batle re attenda di workshop ka di holidays, kapa ha dikolo di tswetswe.

R: why? Even if le tlo befit?

P: Ba re ke nako ya rona to rest. So bare if go batliwa go etsa di workshop then it should be during the school term. So ntho eba e emphasis ke hore re attende workshop ha sekolo setswa. Di school holidays le weekend ba na le bothat le tsone.

R: So in terms of the tools that you used at the river to catch microorganisms, bana ba itse yang ka tsone le gore di bereka yang if ga ba ye ko nokokeng le di living organisms tsa ko nokeng? Le gore hape hape the idea ene ele go checka water quality

P: kore ke nahana hore next time if gwa etsagala le gore le rona santse re tshaba metsi and re tshabela bana.

R: Dinoka tsa lona ke tse kgolo?

P: vaal river yon eke e kgolo. But mo ne ba re isitse teng, ne ba re isitse kae kae but ho a tshabea. Maybe ntho eek a etsiwa gore ban aba kgone go bona hore go etsagalang. Metsi ao aka giwa gore ban aba kgone go bona. Re ba botse dipotsa ntse re ba lemosa. Because hoyo le bona nokeng ke mathata.

R: and then in terms of skolo, how is your relationship with the community especially around environmental things? And water related things?

P: ae relationship ya rona le skole le community? Ae nna ha ke tsebe

P: ga ese community ka ofela ka gore community yak o di rdp, ae aketse

R: So le na le go etsa meeting ka tsona this issues?

P: we have never had a meeting, are so ka r aba bitsa re bua ka tsona di issues tse.

R: and then ke eng oka reng ennile success ka workshop?

P: nna ha ke tsebe, ke hore re enjoyile this workshop. e nkile two days and after that ne eketse hosane re kaya hape.

R: so ne le etsang individually so?

P: akere ne ho na le di games tse re neng re di bapala tsa di card, tsona tseo tsa ho purify metsi. Ne ho le monate, ne ese ntho ya hore ne reile fela be re dula fela classeng. Ne re tswa reya kantgle neng neng re ile metsing.

R: So yona energy eo, the fun that you guys had at the workshop, ke eng eo editseng gore oka e tlisa mo ko classeng? Bo monate bo o buang ka bona?

P: ha re fitlha mona re buile fela ka molomo I think, le bana re ba buditse fela ka molomo hore ne hole monate re etsa so le so. But ya hore re nahane gore re etse le bana, ha ra etsa.

R: why?

P: yhooh I don't know. Maybe ke gore re busy too much, mara re qoqile fela ka molomo. Ha ke hopole re etsa activity. Ha ke hopole hore re na le activity e one e re kileng ra e etsa le bone.

R: Wa hopola one o mplella hore batho ba workshop ne ra itse ba tlo bowa gape and they didn't because ne le le busy, so ne le le busy kang?

P: ne re le busy re batlana le di tena. Le re batla gore bat hole dintho di le up to standard. Ba thole di map di le maneng, bathole di buka tse ba re fileng tsona e le gore dia sebetsa. Kore ntho engwe ke engwe e ba neng ba re file yone at the workshop ne re entse hore ya sebetse hobane ne ra ritse batlo tla hape. So ne re sa batle bathole ho sena ditena, le k abo foundation phase ho sena di bucket tseo.

R: So if nkabe ba etsa every year yone follow up eo, nkene le le up-to-date?

P: ee nkene re le up to date (ideal)

P: this is because if re ultwa hore motho watla yohoooyohooo ra lokisa, so jwale rona re lebetse. So rona re nkile gore after follow up rona re feditse.

R: Mara mathata a metsi o na?

P: Mathata a metsi ona santse re na le one. Ka kgola le gore metsi gona jwalo the ha ayo. Ke yona taba e ya gore go satla ho ba le shortage ya metsi. Ebile nako dingwe sekolo se tswa early ka taba e ya bo thata jwa metsi.

R: okay ke a leboga. Is there anything you wanna to ask that I didn't include e o naganang gore its important?

P: nope, I don't have any

P: oh nna my question ke gore ke mong ntho e e tsohile after so many years, ke 2016 now, so ke 3 years. Is it possible gore those people ba tlo gutla gape?

R: it is not necessarily because ke naa ke batlang. Water affairs e batla go bona gore what are the successes and the failures, so that they can draft an alternative plan. So we just doing a follow up to see what is working.

Principal interview (Second version of the transcript)

Key Researcher: R

Participants: PR

R: ke tlo start aka gore, do you still remember what was going on at that time regarding the workshop that the teachers attended? Ke mang aba biditseng and what was the purpose?

PR: if I remember well the workshop was about, it was in connection with water and sanitation. And the service provider at that time was, if you can remind me

R: wesa

PR: Yah WESSA, because those people promised us that they will deposit the money into the school account, I am not sure. Maybe mam has given you an indication on whether they did or not. They ran the project for two years if I am not mistaken

R: mhmmm

PR: Uhh the first time I saw it working. Learners were participating. There were facilitators who were coming, but at the end of the day, I can't say who benefited. I did not see anything

R: oh cause bo Mam were talking ka gore the ideas tsa go tla ka di bucket ko classeng

PR: they did come up with those suggestions of how best can we save the water and at one instance there was a move that for us to save water we must out a brick in the bathroom and I said to them go ahead. I said that its okay, so that we can see how best we apply their suggestions. The save water thing we took a discussion around it, and ya di bucket it was a recommendation.(existence of something)

R: So then in terms of, ke batla context ya the community around gore le bereka ka community e yang in the school, around the school like ya ban aba, di parents tsa bone or e bana ba batswang ko yona?\

PR: it is a very very very poor disadvantaged community and this area is a formal informal settlement. And as you can see around here it's RDP houses. Majority of the parents here are not

working. The stats have shown that about 80-90% of the parents are not working. We have serious behavioural problems that we see, and when we call the parents you find that the age group that most of the learners are coming from, they are from broken families. Where you find that the father is that side and the mother is that side. At most some of them are staying with their grannies. We can't really expect their grannies to help them with homework. We are really struggling.

R: Mhmm, so how old are their parents?

PR: the range must be just above 25, most of them are just above 25. I have 26 years in teaching experience. So you will find that there are some learners that I have also taught their parents. You will find that I have taught their mother in grade 12 and now they are in grade 4. There is some generational gap. I want to come to this one, I am sure you are aware. It was there in the newspapers that such was conducted and it was discovered that most parents in the informal settlement, their children are struggling at school because their parents drink alcohol whilst they are still pregnant. You will see that the child is not doing well not necessarily because they are not focused but because there are problems. There are problems with their cognitive structures due to their parents drinking during pregnancy.

R: mhmmm okay

PR: Those learners need to be referred to special schools but you will find that the department takes long to respond.

R: and in terms of participation of parents in school matters?

PR: Those that are related to academy and stuff they are more concentrated

R: like for instance?

PR: When we make the budget, when are we going to buy books? Problems such as how best can we improve the performance of the learners in becoming the best they can be. Even if you issue out an invitation that there is this and that it becomes a problem. They don't show up. Even in the SGB it's a problem.

R: So with regards to environmental affairs or water related issues?

PR: uhh they don't participate. They not even active as we speak.

R: is the reason

PR: Political purposes. You why? What see since the previous election. There was this division between DA and ANC. The area must be ruled by DA. The area must be ruled by ANC, EFF and etc. you see them when we have parents meeting. The last time when the school had a parents meeting was last year in September. Do you see the type of school that we talking about, that parental involvement and support is very weak.

R: so because now we are concerned about water and things like that and we think that schools can be mediators to the communities and inform them about the environment and stuff. What are the possibilities and stuff.

PR: You know in terms of the school structure. The composition of the SGB, let me start ka yone. We have the parents, teachers and the peer stuff. The people who are working at school who are not educators. They must be represented in the SGB all the stakeholders. It becomes easy when we discuss issues in the meeting but for us to take it out and mediate it. all the structures in the SGB have to report back to the people that elected them. So I as the head of office I have to make sure that all the decisions that are taken on the meetings are implemented. But when we go make delivery, parents must talk to other parents, teachers must talk to teachers and peer educators will then also provide assistance. But in reality they don't do it like that, they expect the principal to be the jack of all trades.

R: why is that the case though?

PR: People don't want to work. They join the SGB for wrong reasons and not right reasons. And that is the problem for most of the school, it is not only our school. now the issue of water and environment, I don't remember them having contributed anything. I will give an example. We have a serious problem of pressure in school, I mean water pressure in foundation phase. Even if things are normal, there is not enough pressure to give learners water. Sometimes around 12pm there is no water in foundation phase because of the pressure. Most of the people in the community are using water. If you have little pressure, you are not going to get water from the taps. I have raised the matter with the SGB and the matter was left unattended up until I took the matter to the department. The department then promised to give us funds for a borehole and other things. Unfortunately after some time the department did not give us any money due to limited funds and the project was no longer possible. But we still have that problem of water even now.

R:and in this project around water, we were also concerned with some of the activities that the teachers have done in the workshop. One of the activity was checking the water quality and the other one they were supposed to go to the river and teach learners about microorganism and

water quality, so what is your take on that? Because they were saying that there is that fear of water and also some security and safety concerns for learners.

PR: yhooh it is challenging, especially at this school. to take learners to the river.

R: what do you think are other challenges that you see beside the fear?

PR: You see in most of the cases once you say to parents that now learners are going to the river there are so many concerns that they have. Mind you this are Africans and they have their different values and beliefs. They associate water with something else that I don't want to mention. So an environment that is conducive for teaching and learning where the interaction between teachers, learners and SGB is harmonious it can work. Here it becomes even more difficult to call a sport day, it becomes difficult because of the gap that exist between teachers and parents. So that is the fear more especially going beyond the curriculum such as going out of the school premises and doing experience, our teachers fear what and how parents would respond to that. The situation is just bad.

R: So the engagement of the community with the school how is it?

PR: there is no platform that you can engage. Like parents meeting, community based structures inviting us, I have never been to a community structure where they come and talk about the school. So imagine when parents do not engage how are we going to meet and discuss some of the projects that we are running. Except the issue of water, when one says environmental issues, we have people that are dumping their waste next to the school. we have reported the matter to the SGB and we told them that this school will never ever be clean. How do you allow people to dump things in front of the school. You will also see when you go out. There are a lot of papers in this school especially if it is windy. And when you go out, imagine an environment where dumping is just in front of the gate, how is the school going to look like? Is that environment conducive for learning and teaching? You will see when you go out, you can even take photos with your phone. So that is 100% the responsibility of the SGB not the principal. The principal doesn't stay here; I am not a community member here.

R: so how is the surrounding affected by the water issues, do they have water quality issues or just issues with water in general.

PR: the surrounding communities, how would I know? They don't talk. Normally I don't want to associate it with what is happening now, because we have been given notification of when will have water restrictions. So you don't know if the water is closed, or it is a leak, or they are just restricting

the use, you will never know. They don't inform us on time to say, you won't have water. You only find out when you use the toilet or want to drink water that taps don't have water and there is no reason as to why. So it's happening frequently, but coming to the school yard the water quality is out of 100 I can give it 45 cause I was told in grade R, when you take a glass and you put water there are some substances. We thought that because the school is new and was built in 2011 the pipes are still new and with time the particles will go off, but since 2011 none of the school member in terms of parents or the educators or learners experienced any sickness associated with water, no one.

R: So when educators go for workshops what kind of support is given to them when they return?

PR: the kind of support?

R: Yes

PR: in terms of money?

R: any support that the school gives to them

PR: in the school if there is a workshop that is related to the curriculum, no teacher who is teaching that particular subject will be denied the opportunity to go and partake in that workshop. As that will benefit the teacher personally on their personal development and it will also benefit the school. They are supported 100%.

R: What are the kind of environment that they give feedback to?

PR: What we do here is that when the teachers have attended the workshop, 3 days after they need to give feedback to the school. where they will explain what was the workshop about, and in most of the cases we do that in our morning meetings.

R: Is there any method that they use to give feedback?

PR: There is no prescribe method of giving feedback, they can do it in whatever way. usually some teachers would say that they cannot give feedback in just 15 minutes and they will ask that we reschedule a meeting for their presentation or they prepare handouts for other teachers.

R: and for this teacher that attended the workshop, did they give feedback?

PR: They did give us feedback.

R: and how was it received?

PR: Teachers are on the receiving side and their reception is good. What will left of is the people that are leading the programme or the project. How are they going to push to make sure that what they have gained from the workshop is implemented? In most of the cases if you don't push people will relax and remain where they are. Like even with the workshop I cannot tell you what went wrong, some of the recommendations were not implemented. It means the project coordinators did not push to that extend or maybe they did not understand. I am not sure. But to a certain extend they were supported, I remember at some stage some of the learners had a drama where they performed concerning issues that were related with water. They managed to get position 2 or 3 I am not sure. That really shows educators did understand at that time. They have also pushed in implementing some of the recommendation from the workshop.

R: how do you relate yourself with water personally?

PR: I like water, I respect water, water is my life. Every morning I drink about a litre of water. I carry water with me wherever I go. Even my kids know that. Water is my life, maybe is because I was told that for one to reduce a lot of acid in their body they need to drink a lot of water. And I am suffering from gout so I must drink a lot of water.

Principal (First version of the transcript)

- The service provider was WESSA
- They ran the project for two years
- For the first year it seems to be working, learners participated because there were facilitators who came to check the progress however I cannot tell who benefitted at the end because I did not see anything
- And educators did came with suggestions about brick in the cistern and keeping drinking water in the buckets instead of learners – and the bucket suggestion was accepted
- The context – very poor disadvantaged community, this area is a former informal settlement that is the reason why you see RDP houses.... Majority of the parents are not working about 90% according to stats SA ... we have a serious problem with behavioural discipline When you call a parent Age group of most of the learners are coming from here are broken families.... Parents living in separate places.... And some kids are raised by grannies and it's difficult for grannies to help them with homeworks Their parents around just above 25..... I have been teaching for 26 years of experience, so I taught their parents and the child is doing grade 4... so you can imagine the generation we are dealing with.... Most of the parents at this age in the informal settlements it was discovered (in the newspapers) that they struggle in schools because of their exposure to alcohol abuse and drugs whilst the mothers are pregnant... they are those learners you can see that they will not pass when you start with them in the beginning of the year not because they are

stupid or anything – it is in terms of their cognitive structure and the district is taking their time to make them referred.... Parents are only interested in the academics of the kids only when it involves budget (money) and when the books are going to be bought but if it is about engaging them to bring ideas about how to best improve the results of the learners they do not turn up even inside the SGB The problem becomes worse if you invite them to engage them in water issues they won't participate.... We don't have an active SGB because of political problems.... DA and ANC and EFF divisions amongst the parents and that become evident during the parents meetings The last time we had a meeting was last year 2015 September.... So the parents involvement and support is very weak....

- School being mediators for the dissemination of knowledge about water saving and conserving – in terms of the schools structure, let me start with the SGB composition; we have the CEO of school, parents, teachers and Personell staff, people who are not educators but working in the school....they are all representations.... It becomes easy if we discuss the issue as the SGB and want to mediate it they go to their respective community to mediate the message who have chosen... I am the CEO I ensure that decisions are implemented so when coming to the service delivery parents must talk to the parents, educators with educators and so on, ... but this is not happening like that instead they expect the principal to become 'jack of all trades' People are in the SGB for wrong reasons that is why you do not see people not wanting to work for the best interest of the school...
- The issue of water and environment, I never saw them contributing because for example we have a serious problem with water pump pressure in foundation phase, there is no enough pressure to give them enough water, most people in the community use water I raised the issue in the SGB meeting it was not taken up until I went to DWS and they referred us to Dept of Transport and has promised to give us money from Road accident funds to make boreholes....unfortunately later when we contacted them they said they have ran out funds and the project has to end... but we still have a problem of water even today...
- Excursions of taking kids to rivers – it's a challenge especially in a primary school level.... Once you say to the parents that you are taking the kids to the river, it will become a problem because remember these are African parents where they have different values and beliefs to the western culture.... They associate water with something else....the environment where parents, educators and learners work harmoniously is possible this schools context is different because we can't even do sports trips because of the gap that exist between educators and parents.... That is the fears of educators have regarding going all out outside the curriculum Extra-curricular....
- We have a bad communication we can't even create that platform as a school even the community doesn't involve/invite us in their meetings....
- Besides the issues of water and the environment – we have a serious problem where have people who dump rubbish opposite the gate of the school and I raised that to the SGB to say this school will never be clean how can they allow the community to do that, there is rubbish everywhere in the yard of the school especially when it is windy.... So imagine the environment of the school with such you would then ask yourself how will that school become an environment for teaching and learning..... that is a responsibility of the SGB....

- How is the community affected by water quality issues – I would not know because I do not live here and they are not involving us... usually the municipality does not inform us the reasons of why they close the water or even tell us in advance... so water closing happens frequently and you can only know it when you go to the toilet not flushing or when you open the tap and the water doesn't come.... I would give the Water quality of this school a 45% because I was told that if you can take a glass and pour water in it one will observe black substances initially we thought because the school is new (2011) and the infrastructure too, we thought the particles will fade but none of the school member experienced illnesses associated with water....
- Educators support going to workshop if they are related to the curriculum they are supported.... According to the policy the Feedback should be given to the entire staff within three days after the workshop.... We usually have morning briefing where educators get opportunity to do feedback.... In whatever way..... and educators who attend workshop have the responsibility to coordinate of ensuring that their suggestions/recommendations and knowledge gathered is implemented in most cases if you don't push people will respond....
- At that time some learners created drama concerning issues of water in the district competition and they won position 2 or 3, that really showed their commitment...
- How do you relate to water – I like water and respect it, water is my life...I can't go hours without water,... I carry a bottle of water wherever I go...every morning I drink a litre of water before breakfast.... That's my motto.... Maybe it was because I needed to reduce acid in my body because I'm suffering from ulcer and gout... so I must drink a lot of water.... And besides before I was a sportsman I know the importance of water.....
- Culture/ Tradition: when the place is hot, the first thing you do is to taste the water and if you want to know what the experience is like in the area - which determines how long you are going to stay in the area – if you do not have money you will stay but if you do you will leave....for example I attended my tertiary education at Turfloop in Lebowa, you can imagine moving from the Johannesburg waters to their waters, in the beginning it was difficult to get used to it even when I washed with it my whole body was itching... but few years I went there the quality of water has improved a lot...
- Leadership: Corruption that is done by our political leaders is unacceptable and no one reprimand them and they are easily getting away with it.... But as a principal if I take R200 the community will wait for me at the gate harassing.... It is painful and what is happening at higher places affect us....if the head is sick the body will not function properly.... And if you leave the head then the body will stay suffering...
- How would you encourage the people to participate: I have changed schools 7 times and every school was different, so far it is only here where the context is extremely different and difficult..... empowering SGB is key.... The model of giving the SGB more power than the principal is a problem.... Water and environment are the issues of governance So the channel is as the principal to communicate with the community I need to pass first through the SGB and I do not have the authority to call a meeting with the SGB either.... So if I have the issue I have to ask the chairperson to call a meeting and the secretary and discuss the agenda.... So it is the problem... and some of them are literate and becomes a problem...

Municipality - Metsi-a-lekoa interview

- There are two sides in terms of the operations; we have the social side and technical part (water quality monitoring and tests)
- I am responsible for the social part... customer relations and services, communication, education and call centre, management
- What was the rationale for the workshop: we were invited by ORASECOM through WRP which was the consultant we appointed for the project we were doing on Boloka-metsi which is a water saving project... where we doing the internal strategic repairs where we were losing a lot of water, and the system's volume and the costs... so in that workshop there were different programmes presented and discussed and we as Emfuleni had to explain what Boloka-metsi was about and around the issues of integrated programmes of the Vaal river system – challenges that DWS is dealing with ...
- Emfuleni was playing the key role in the issue of water reduction programme – because we are closer to Vaal river and vaal dam, we are one of the the biggest municipality after the metros, in term of the consumption patterns we had a high rate of water losses so we had to address those water losses....
- Water quality – our main distributor is randwater and we are relying on randwater systems for our distribution and if there is water quality issues they are the first people we engage with...but we also have our own internal programmes water quality monitoring unit in different areas....
- They have they are own blue drop for the municipality distribution as well as us the municipality we have our own blue drop for our end users, i.e. consumers
- Green drop – we are managing and monitoring the three wastewater treatment plants that goes back to the river system....we were strategically located because Vaal dam is our source of supply
- High rate of water losses – cost incurring in areas we are supplying, leakage, wastage, infrastructure maintenance, internal leakages in the households were a major challenge..... interventions was established which has led to the Boloka-metsi has led us to appoint WRP as a consultant and we were in partnership with the GIZ and that's how ORASECOM knew about the project through GIZ and other stakeholders like the DWS
- Water supply and wastewater treatment plants are separate and different issues..... out of the three the two wastewater treatment plants infrastructures are old they were built in the 1960's/70's, the second problem is that the human population is increasing more than the infrastructure capacity[i.e. the infrastructure is not growing] it used to be the small Vaal triangle and now is a big municipality towards a metro status, ... so the plants were refurbished so that it can effective....
- Water supply – water leakages boloka metsi project
- Do you communities relating to the streams directly like swimming, fetching water etc? ... Vaal river is the main river and the Rietspruit is also another stream...
- Rietspruit flow is coming from up the North – from Joburg, Orange farm until Emfuleni so whatever is polluting the river system is not always coming from Emfuleni but you need to consider that the upstream challenges are transferred into emfuleni....
- Informal settlement – we tried to reduce the informal settlements by introducing the RDP but there is still some pockets of them here and there which are growing.... In most of the

informal settlements which are being formalised we have pit latrine system and some of the areas are temporary toilets....

- The rationale for selecting primary schools: we have a social programme, schools programme, awareness and education to the general public, targeted programmes on different sectors e.g. religious, youth, etc, ... we had already partnered with certain schools in the education and awareness programme and secondly some of those schools had already had initiatives and we were supporting them around water saving projects, harvesting water, food gardening from randwater water, they were identified on those bases.... Plus we also take them to randwater via WaterWise project to see how water is purified every year, and take them to our water treatment plants for a tour.... Every year we use different approaching to engaging them, some years we had competitions where they will do posters.... We are building the pressure station so the winning schools will paint the station...so we building and encouraging young people around issues of waterwise....
- Do you do follow-up? we do follow-ups in those schools in this way we workshop the school first, then the tour then visit them to see the progress of the implementation..... for instance...to check their toilets and tap leakages, the irrigation system they use for their gardening...
- How continuous is the monitoring? we are doing it at a minimal level because of lack of resources, lack of capabilities in terms of human personnel which is a challenge... we do have a system where our customer relations go and check.... But it is unfortunate that we cant hold the schools accountable of implementation it is the Education Department who are supposed to ensure that...
- Do you liaise with Education Department and other stakeholders to ensure that each does their part?... Yes...there are two districts one responsible for the west and the other for the south....they give that access and facilitate the process..... we can now deal with the schools directly in particular primary schools....we do have some programmes in high schools but only awareness.....
- Why primary school? we feel it is where we need to start because the age, and the ability of grasping information and transmitting of the information to their parents....
- Necessary to have personnel who can monitor the progress in schools? Yes it was going to make our lives easy...cos currently I have only one person who deals with school but the workload is too much....cos challenges are many..... because if there is only one person monitoring because of many schools and rounds whenever the person try to move forward some schools left behind will regress...
- What is the best way to hold schools be accountable?...municipality must have focus on that in ensuring some of the challenges are resolved....
- Our area is almost 83% urban, 13% is rural...so our main focus is in the urban area where we supply portable water so there is no compelling reason for them to go fetch water from the river and even in the informal settlement..... so our supply is safe in that way.....
- Pollution of streams is there and the challenge is when the infrastructure is failing, and flows from upstream outside of emfuleni like sewage leakage in the rietspruit and klipspruit also coming from mid-vaal... and we are at the mouth of the river system..... but we as metsi-a-lekoa and emfuleni municipality are not responsible for the quality of the river system it is DWS and Randwater....what we do is just river quality education and

awareness, ...we have programme with NGO's around Evaton and Sebokeng challenges we experience about pollution, littering and manhole blockage but DWS will respond to them.... We have environmental management section in Emfuleni which deals with all kinds of pollution like water pollution, air pollution, etc..... we deal with pump stations

- We have special programmes with NGO's that are contextualised for instance those who live adjacent the river and those who are not... e.g. Phaphamang in Evaton...they have their programmes which involve schools and awareness and they are monitoring the stream...e.g. cleaning of the streams.....
- Running these programmes sometimes help because sometimes we assume that people know but their actions say otherwise and that knowledge is important to all communities....and secondly their actions of all will affect each other.....
- Klipspruit.... Midvaal also experience the same problem we are experiencing about them because they have industries in their system who pollute the stream.... The kliprivier waters can tell you how the midvaal is behaving.....
- Environmental management unit does not have enough capacity BUT DEA and DWS has appointed RandWater because they dint have capacity either....
- Who else do you work with randwater is the only distributor/supplier from this side of Gauteng no competitor...
- Metsi-a-lekoa is a business unit was established in 2005 and is divided into water, sanitation, maintenance, planning and projects and customer services.....
- Has the water issues reduced over time?....quality, supply, education etc....
- Firstly we are receiving complains...communities are aware on what to do when they face challenges regarding water issues....the critical point was fluctuating as you face different challenges and depends on the municipality resources..... what is happening right now is that the infrastructure is failing because for instance there are pipes in Vereeniging that were last repaired in the 1950's so they keep on bursting and they are affecting business people, there is always blockages and besides Vereeniging is old 1905 so it depends on the kind of situation that occur in a particular time...
- How do your workshop have effect on the people? usually after the workshop people will be aware of their situations and they will start reporting..... That must be accompanied by a prompt response to build trust.... They are effective via our observations....
- Customer relation person has to monitor his area - site-visit, sewage, leakages, write reports,...
- How do you document? We use a water management system (WMS) that record activities on a daily basis.... We will have a night shift system.....
- What are the water quality conditions Randwater water quality is complying with the standards and availability is ok... water restrictions has been gazetted cos the dam level is at 32%.... we are still distributing but there are areas that will be affected more than the others we distribute domestics and business but only portable water.. for raw water for big businesses like ISCOR get it directly from Randwater ...

Appendix 12: Educational poster about water quality

The colour of the crabs indicates a score-range of water quality. Participants predict the quality of water depending on the social, economic and environmental activities they observe.

