



**TOWARDS REALISING THE BENEFITS OF CITIZEN PARTICIPATION
IN ENVIRONMENTAL MONITORING:
A case study in an Eastern Cape
Natural Resource Management Programme**

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for the degree of**

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by

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Abstract

The Tsitsa Project focusses on land use management and rural livelihoods in the Tsitsa River catchment in the Eastern Cape Province of South Africa. It is funded by the Department of Environmental Affairs and the environmental monitoring initiative is implemented by Rhodes University, where I am employed as the catchment coordinator. This study explores the environmental monitoring initiative within the bigger Tsitsa Project. Community members in the catchment monitor sediment transportation in the Tsitsa River and its tributaries, which originally became of interest because it is proposed that a dam (Ntabelanga Dam) be established here. This study aims to understand citizen environmental monitoring in the Tsitsa Project; what the project managers regarded as benefits; and how the monitors themselves perceived benefits of participating as monitors. A realist approach was followed, in order to understand the connections between the context and the mechanisms in the project, and how these combined to result in the outcomes observed. Realist research emphasises the importance of context in shaping outcomes such as the achieved benefits of citizen monitoring. Data was collected using a case study method, where each individual monitor and their particular context, was regarded as a case. Semi-structured interviews were conducted with 17 monitors and five Tsitsa Project staff; this was supported by field notes and the reviewing of project documents including field reports. The realist analysis looked at the context of the monitors in general and the mechanisms applied by the project in recruiting, training and managing the monitors. A second layer of mechanisms was identified as those responses from the monitors to what the project was introducing to them. Outcomes were both positive and negative, including how long monitors remained in the initiative, what benefits they derived from the process, and what potential benefits they did not achieve. This included lost opportunities to provide recognition for skills and experience gained. Recommendations are made regarding the recruitment, training and management of monitors, to optimise benefits for the monitors, the host institution and the initiative's staff. The study is significant because of its particular yet representative characteristics and it will assist both the Tsitsa Project, which aims to expand its citizen environmental monitoring initiative, as well as wider Natural Resource Management Programmes in South Africa. It is also hoped that it will contribute to the literature on environmental monitoring as a little researched form of citizen science globally.

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Acronyms

C	Context
CLOs	Community Liaison Officers
DEA-NRM	Department of Environmental Affairs – Natural Resource Management
EPWP	Expanded Public Works Programmes
GPS	Global Positioning System
K2C	Kruger to Canyon
LM	Local Municipality
M	Mechanisms
NRMPs	Natural Resource Management Programmes
O	Outcomes
WfW	Working for Water

CHAPTER 1: Introduction and Contextual Profile

1.1 Introduction

This study takes place in the context of the Tsitsa Project, formerly known as Ntabelanga Lalini Ecological Infrastructure Project. The Tsitsa Project is a programme that is funded by Department of Environment, Forestry and Fisheries – Natural Resource Management; at the time of the study, the Department of Environmental Affairs (DEA-NRM). According to the programme document, the proto-vision of the Tsitsa Project is to “support sustainable livelihoods for local people through integrated landscape management that strives for resilient socio-ecological systems and which fosters equity in access to ecosystem services” (Fabricius, Biggs & Powell, 2016, p. 8). This chapter introduces the current and historical context of the Tsitsa catchment and the Tsitsa Project, as the background to the study. It describes the environmental monitors part of the Tsitsa Project because my research and rationale are linked to the environmental monitoring initiative. Within the Tsitsa Project, my focus is on the citizen environmental monitoring initiative in which catchment residents are engaged as environmental monitors.

This study explores the environmental monitoring initiative within the bigger Tsitsa Project. The bigger Tsitsa Project focuses on land use management and rural livelihoods in the Tsitsa catchment in the Eastern Cape Province of South Africa. The environmental monitoring initiative is implemented by Rhodes University, where I am employed as the catchment coordinator. Citizens in the catchment monitor sediment transportation in the Tsitsa River and its tributaries, which is of interest since it is proposed that a dam (Ntabelanga dam) be built here. The study aims to understand citizen environmental monitoring in the Tsitsa Project; what the project managers regarded as benefits; and how the monitors themselves perceived benefits of participating as monitors.

Figure 1.1 shows how the environmental monitoring initiative functions with the following key 1: Cell phone; 2: Clarity cube; 3: Sampling pole; 4: Jam jar; 5: two litre bottle with a string. More details can be found in Chapter 4.

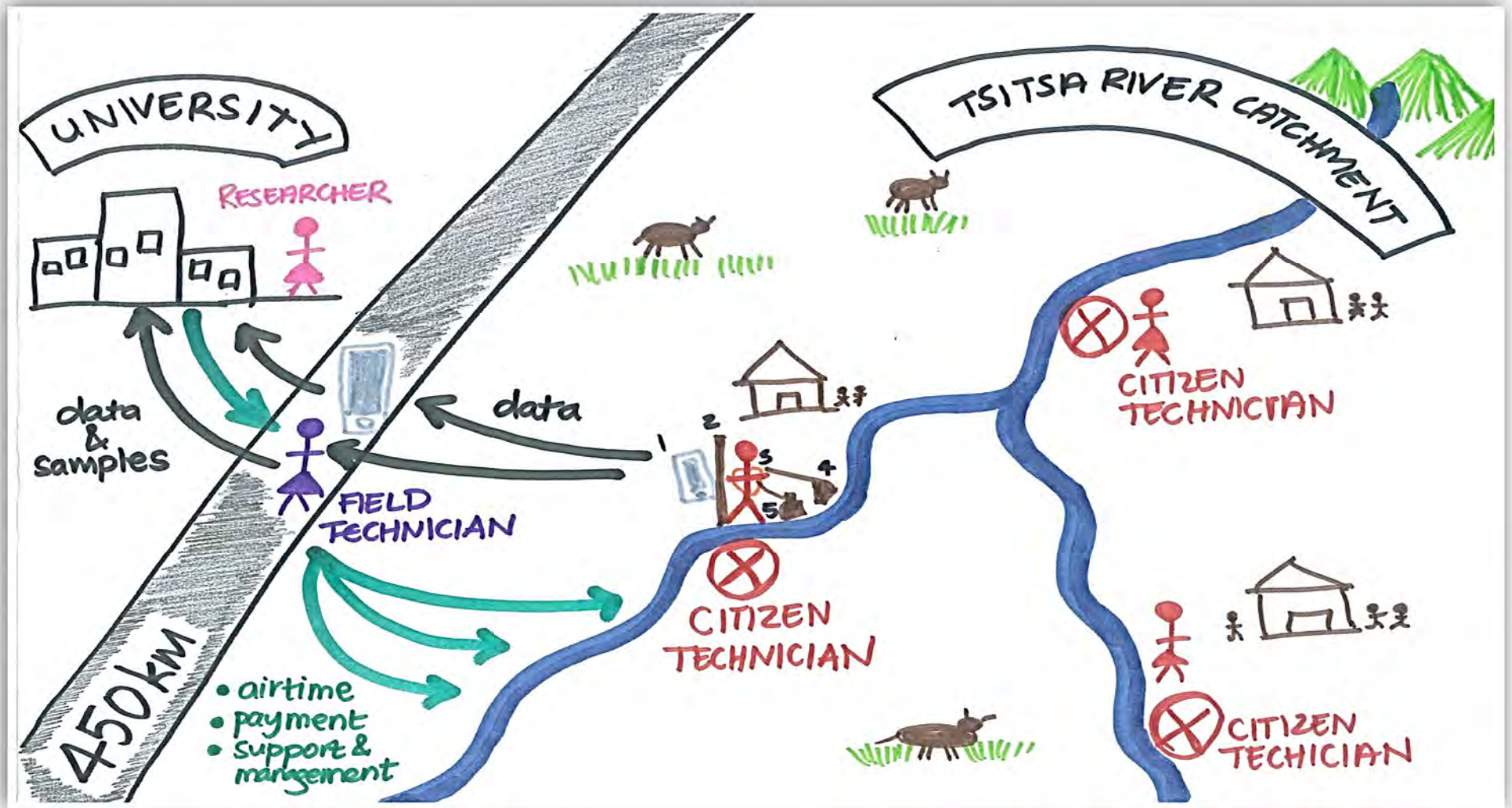


Figure 1.1: Functioning of the environmental monitoring initiative

This chapter introduces the reader to the background of the study which includes my positionality, and an introduction to the Natural Resource Management Programmes which the Tsitsa Project is funded by. It further goes into details about how the environmental monitoring initiative was set up and how it is managed. The chapter also introduces the rationale of the study as well as the goal of the study. Finally, the structure of the thesis is described.

1.2 Researcher Positionality

I joined the Tsitsa Project in 2016 as a field technician which involved helping to manage and expand the environmental monitor component of the programme, as will be discussed in section 1.5.2. In 2017 I handed over my duties as field technician, to become the Tsitsa Project Community Engagement Officer and it was during this time that I undertook the research reported here. Currently, I work as a catchment coordinator, and part of my role is to guide the recruitment and management of an expanded group of catchment citizens employed by the Tsitsa Project, including Community Liaison Officers and Eco-Rangers. The fact that the Tsitsa Project will be expanding its citizen environmental monitoring component, makes it important to understand how best to recruit, train and manage monitors. I embarked on this journey in September 2017. I wanted to undertake this study because I became interested in understanding the environmental monitoring process from the monitors' point of view and from the point of view of Rhodes University staff/managers, that is, the researchers and project managers at Rhodes University and in DEA. Additionally, the university researchers appeared inexperienced in how to work with catchment residents in the rural context, of the project. They had never done this before, and needed to learn how to do it. They were therefore learning-by-doing. I felt that conducting research on the human aspects of the study would be helpful to the learning of everyone involved.

1.3 Background to the Catchment

This section discusses the background of the catchment. It begins by describing the geographic location as well as the political bounding. It continues to discuss the demographics followed by leadership, land tenure, and ends with a discussion on poverty and inequality.

1.3.1. Geographical and political location of the study site

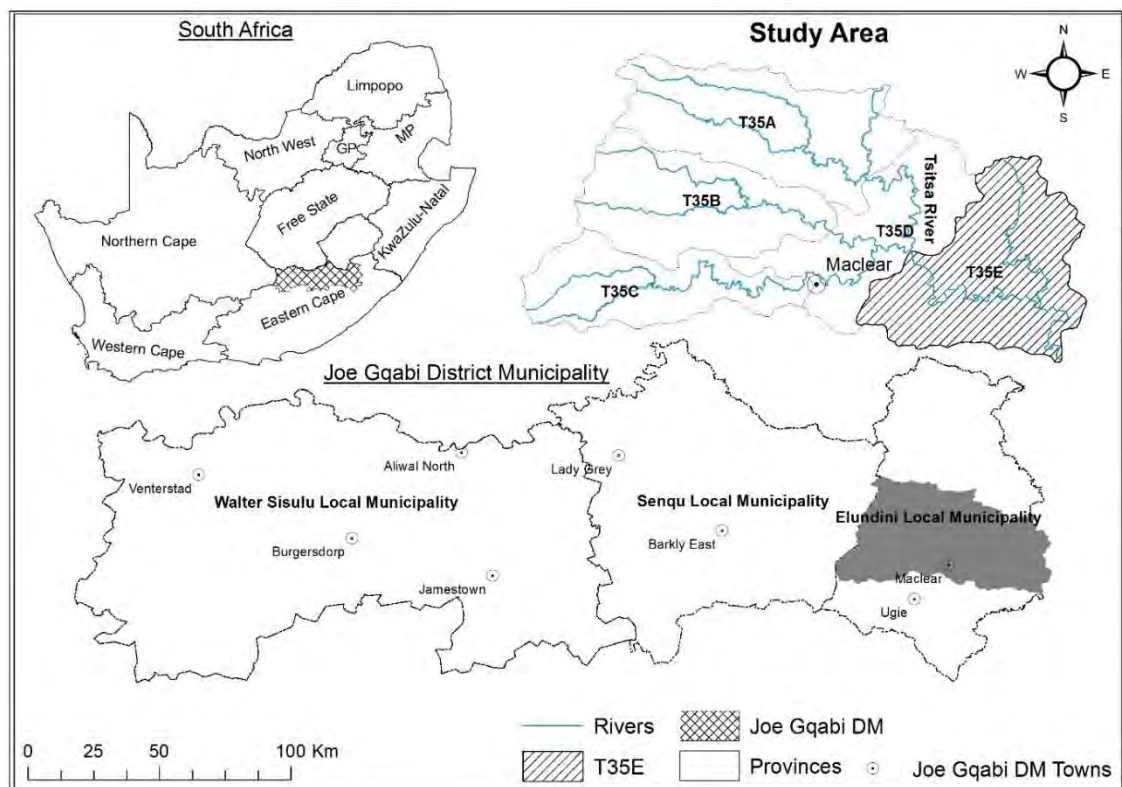


Figure 1.2: Location of study area, as well as the tributaries the Tsitsa River
(Source: S. Mazibuko, 2017)

Figure 1.2 shows where the study is situated within South Africa and represents the tributaries of the Tsitsa River that are or were sampled by monitors. Figure 1.3 shows the two catchments Ntabelanga outlined in purple. The rest of the figure is Lalini catchment. These two catchments fall under the Mzimvubu Water Project (MWP) which has a plan to build two large dams (Ntabelanga and Lalini). The MWP and the proposed dams fall under the mandate of the Department of Water and Sanitation. In the early stages of the environmental monitoring initiative there were sediment sampling sites in both catchments.

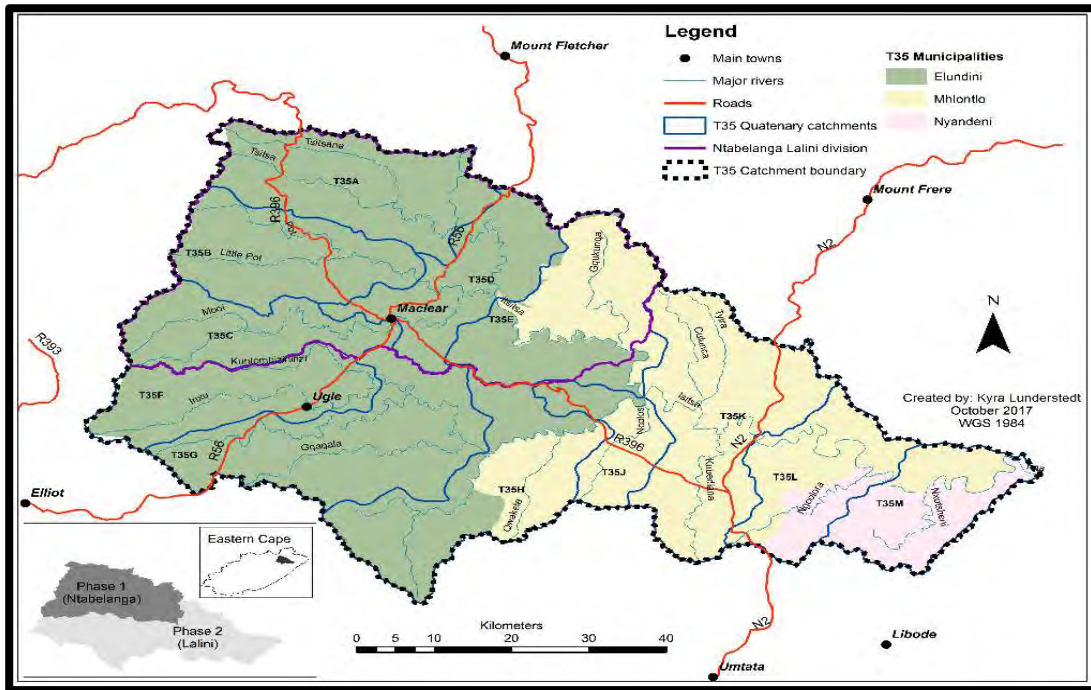


Figure 1.3: Local municipalities in which the bigger project is situated

1.3.2 Catchment demographics

As will become evident in the study, language is a significant factor in the citizen monitoring initiative in the Tsitsa Project. The main language spoken in the Tsitsa catchment is isiXhosa, (by between 70% and 95% of the residents), and the majority of the population are black isiXhosa-speaking from the former homelands of the Transkei (Sigwela, Elbakidze, Powell, & Angelstam, 2017), where most monitors are located, with a few also located on commercial farms (as farm workers). In the catchment there are a large number of commercial farms that belong to the minority White community in the area (around 600 people) where isiXhosa speakers (Black and Coloured) work as farm labourers (StatsSA, 2011; Hodgson, 2017). There are generally more women than men in the catchment, and because of out-migration to find work in cities, there is a high proportion of youth under 15 years (school children) and people over 65 years (pensioners receiving a state pension) (StatsSA, 2011). The average rate of unemployment is 35% (Calmeyer & Muruven, 2015). The majority of Black African people reside either in rural villages or in the township near Maclear, whilst the majority of White people live in the suburbs of Maclear or on commercial farms (Hodgson, 2017). Sisitka, Ntshudu, Hamer and de Vos (2016), in the Ntabelanga stakeholder analysis, stated that there are approximately 80 villages in the easternmost part of the Tsitsa catchment. About 3000 or less people across the catchment reported in 2011 that

they had completed secondary schooling, whilst only about 1100 reported experiencing any form of higher education (StatsSA, 2011).

1.3.3 Leadership and governance in the Tsitsa

According to the stakeholder analysis undertaken by Sisitka et al. (2016), the Tsitsa catchment still has strong traditional leadership structures. There are six traditional councils within the catchment. Each area has its own rules or norms and it is important for Tsitsa Project implementers working in the catchment to learn about and understand them. It is important to note that even in this particular catchment, with 95 % of isiXhosa speakers, there is quite a diversity in terms of residents' historical origins. They are key in decision making on the ground. The six traditional councils are: eLangeni (formerly Ngcele-Tsol) – in the east of the municipal area, adjoining the Mhlontlo Local Municipality, and the Traditional Council within which the southern half of the proposed dam on the Tsitsa River is to be located. This area is described as a Mfengu group. The Senior Traditional Leader (Chief) was, at the time of the study, Mabandla.

- Basotho – to the northwest of the proposed dam, on the western boundary of Mhlontlo Local Municipality. It is a Traditional Council of Basotho origins who historically moved into the catchment from elsewhere. The Senior Traditional Leader is Moshoeshoe.
- Hlankomo (formerly Batlokoa-Flet) – bordering the former to the north-west. Another Basotho derived group which is now combined with amaXhosa and amaHlubi. The Nkosana is Xoza. The Senior Traditional Leader is Lehana but he is not directly involved in this area.
- Lower Tsitsana-Flet – west of the former. The Senior Traditional leader is Sejosengoe, who also claims Upper Tsitsana, although this is disputed by the headman there and the community there.
- Upper Tsitsana-Flet – west of the former. Similar to the Hlankomo Traditional council, there is no Senior Traditional leader. The Nkosana is Mdletye.
- One Traditional council, the Northern Mpondomise-Qumb, falls within the Mhlontlo section of the Ntabelanga sub-catchment. This council belongs to the family of Matiwane. The Senior Traditional leader is Matiwane. (Sisitka et al., 2016)

After the 1994 political elections, both the elected local councillors and traditional leaders bear some authority and responsibility in terms of decision-making regarding land-use and management (Sisitka et al., 2016). Traditional leaders work closely with councillors and their local municipalities. Each local municipality has a council that includes traditional leaders and the political councillors. There are two local municipalities in the catchment, which is Elundini and Mhlontlo, with the majority of the catchment falling under Elundini.

1.3.4 Land tenure

The majority of the sub-catchment, in particular the upper reaches in the west, was designated as land 'for Whites Only' in Apartheid South Africa, and is primarily under private land ownership (Sisitka et al., 2016). It is characterised by private or municipal land ownership (surrounding the main settlements of Maclear, with some leasehold elements (ibid.). The freehold area is characterised by extensive plantation forestry and combined land-uses of commercial agriculture (largely pastoral) including field crops and livestock (Sigwela et al., 2017).

The eastern and northern sections are communal areas which previously formed part of the independent homeland of Transkei (Sigwela et al., 2017). The homeland policy created ten African homeland areas that only made use of 13% of the land and the rest of the 87% was given to white South Africans (Leibbrandt, Woolard, & Woolard, 2000). For 40 years the majority of South Africa's population was trapped and restricted into remote areas with devastating economic and social consequences (ibid.). Homelands were incorporated into South Africa's provinces after the democratic elections took place in 1994 but the scars of the 40 years of apartheid rule did not disappear (ibid.).

The proposed dam falls entirely within this area. The land here is usually characterised as 'communal land', but it is essentially land held in trust by the state, and administered through the traditional authorities. This has considerable implications in terms of the authority of the state to make decisions regarding the use of this land without full consultation with and approval of the traditional leaders and the land users themselves. The land tenure in the communal areas is complex with people being granted permissions by traditional leaders to conduct various activities on different portions of the land, but

there are different ways in which the rights to occupy or use the land are granted. The two main forms of tenure are 'Permissions to Occupy' (PTO) or 'Quitrent', neither of which are considered secure long-term forms of tenure, although in some cases they have been passed from generation to generation (Hodgson, 2017).

1.3.5 Poverty

After democracy was established in 1994, the former homelands have remained highly affected by poverty and deprivation. As indicated above, there are still high rates of unemployment, and the region is also characterised by a lack of infrastructure, service delivery, and human development (education, job creation, etc) (Neves, 2017). Over time, these areas were seen to be descending further into poverty, in which they appear trapped, with poor economic development and limited markets. Local residents are largely dependent on grants and remittances (Sigwela et al., 2017). Many households in the Tsitsa Catchment area are heavily reliant on social grants that they receive from the government. The study area is mostly coloured in orange which means that more than 56.9% of income comes from grants. These grants are given to caregivers for children under 18 in the household, including fostering other children, and pensions for the elderly, among other things. In addition to being dependent on grants and remittances residents in communal areas such as the Tsitsa are partially dependent on natural products for their livelihoods, home gardens and some cropping and livestock (Sigwela et al., 2017). There are limited opportunities to emerge from this via agriculture and forestry or informal sector employment, which leads to long-term unemployment (Neves, 2017). StatsSA (2011) reports the unemployment rate for Elundini as 44.1% and 49.2% for Mhlontlo.

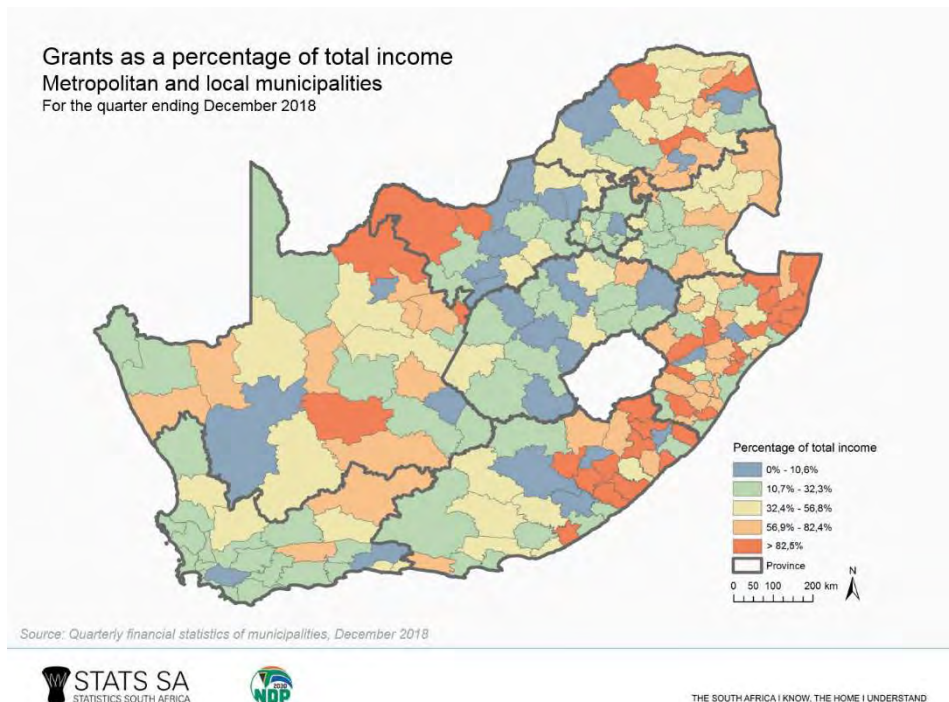


Figure 1.4: Grants as a percentage of total income in South Africa.
Source: Statistics South Africa (2018)

1.4 Natural Resource Management Programmes

“The role of the Natural Resource Management Programmes (NRMPs) is to implement environment-related policy and, through partnerships, restore and sustain South Africa’s natural capital so that it continues to provide the ecosystem services that underpin human well-being” (Le Maitre, Forsyth & Stafford, 2015, p. 9). Their goal is to address the threats to the productive use of land and water, and the functioning of natural systems while ensuring meaningful livelihood opportunities through employing people.

The DEA adopted an “outcomes based approach” in trying to improve government performance and be better at service delivery, given the socio-economic status of South Africa (online: https://www.environment.gov.za/branches/environmental_programmes). The Government introduced the Expanded Public Works Programmes (EPWP) initiative (ibid.), an initiative dedicated to employing people in a significant manner which will allow them to gain skills, build their capacity and enable people to enter the formal workforce while they earn some income (Le Maitre et al., 2015).

The ultimate goal of the EPWP is poverty alleviation and uplifting households through job creation, and skills development (https://www.environment.gov.za/branches/environmental_programmes). The balance is always between social, economic and environment for sustainable living. Natural Resource Management Programmes are one kind of EPWP programmes which encourage and support sustainable land use practices while raising awareness and promoting resource conservation ethics within and by communities. (https://www.environment.gov.za/branches/environmental_programmes)

1.5 The Tsitsa Project

This summary is based on various Tsitsa Project documents and publications, including the Research Investment Strategy (Fabricius, Biggs & Powell, 2016), internal project reports, research papers (Cockburn, Palmer, Biggs, & Rosenberg (2018); Bannatyne, Rowntree, Van der Waal, & Nyamela, (2017)), and theses (Nyamela, 2018 and Bannatyne, 2018) produced by students that are part of the Tsitsa Project.

The Tsitsa Project is a DEA-NRM funded programme, as mentioned in the introduction, that has been tasked with community-based land restoration in the north-eastern Eastern Cape, that aspires to help sustain livelihoods in this part of the country through building a healthy social-ecological ecosystem in the landscape. Besides government, several university departments are involved in the programme, and Rhodes University plays a leading role. With regard to the environmental monitors initiative, the Tsitsa Project's objectives are (Fabricius, Biggs & Powell, 2016) to improve catchment residents' agency to undertake land management through capacity development and improved governance structures which will hopefully result in better ecosystem services that will support residents' livelihoods now and in the future. Better land management will also hopefully slow down the predicted siltation of a proposed dam (Sigwela et al., 2017).

The Tsitsa River is part of the Mzimvubu catchment. Therefore, the Tsitsa Project falls in the bigger Mzimvubu River, which is the last remaining big catchment in South Africa that has not been dammed (Calmeyer & Muruven, 2015). The proposed dam is seen by government as an opportunity to provide water for a number of district municipalities surrounding the catchment. This is an area with soils highly erodible, hence the suspended sediment studies conducted by Rhodes University. The Tsitsa Project Sediment and Restoration Group

(environmental monitoring initiative from here onwards) began the environmental monitors project as a result of recommendations made by Le Roux and Weepener (2015). They suggested monitoring of the discharge and suspended solids to determine the contribution of the sediment from the Tsitsa catchment into the proposed dam.

The Tsitsa catchment is approximately 4 000 km² and situated about 450 km from Makhanda (Grahamstown) where the project is managed. Suspended sediment studies require short time interval monitoring in order to get useful data that can represent the catchment as a whole. Normally, gathering this sort of data is very expensive and it is not always accurate or collected as often as required and in as many localities as possible (Bannatyne et al., 2017). This led to the need for the environmental monitoring initiative to engage catchment residents as environmental monitors.

There is also a national call for including citizen science in more NRMPs, as a means of alleviating poverty and creating job opportunities, but there is little known about citizen science in these kinds of contexts, and therefore there is much to be learned and understood in order to manage the programmes and work towards intended outcomes.

Involving locals in collecting data is advantageous because they can sample on a daily basis; this is cost effective and potentially beneficial for all parties involved including the Tsitsa Project, DEA-NRM and the locals. The well-known term for citizens that participate in the collection of scientific data voluntarily is citizen science. I will elaborate on this topic in Chapter 2. The Tsitsa Project's environmental monitors' initiative opted to call them 'citizen technicians' because they are doing work that is technical and they get paid for it.

Unpublished NRMP literature uses the term 'environmental monitors'. This term 'environmental monitors' covers a range of fields within the collection of data by citizens and monitoring of the environment. For the purpose of this study, the latter term was selected as the outcomes of this study will feed into the NRMP literature.

Given the socio-economic status of the catchment, the research team made the assumptions that without an incentive in the form of payment for services, the sampling protocols were unlikely to be adhered to, and the programme could not then be expected to provide data of the required confidence level (Bannatyne, 2018).

Bannatyne and Nyamela both conducted studies within the Tsitsa Project and focused on the data produced by the monitors to try to understand the sediment transportation in the Tsitsa River catchment. Nyamela (2018) focused on the suspended sediment yield and the provenance of the Inxu River catchment, Eastern Cape, while Bannatyne (2018) studied Developing a Citizen Technician Based Approach to Suspended Sediment Monitoring in the Tsitsa River Catchment. I have referred to these studies as supporting documents for this study. I draw extensively on Bannatyne (2018) because she focused particularly on working with the monitors.

Box 1.1: Description of the key to the different role players in the study

1. **Environmental monitors:** Local citizens that collect water samples
2. **Host institutions:** Rhodes University and DEA-NRM
3. **Managers:** Managers of the environmental monitoring initiative (field technician, including an intern and government official)
4. **Researcher:** Student researcher who worked with the monitors to collect sediment data

1.6 Process of Setting Up the Environmental Monitoring Initiative

This section discusses environmental monitoring initiative. It begins by describing how the sites were selected together, to how the monitors were identified, to how they were trained. It then discusses the environmental initiative. More details about the monitoring are outlined chapter 4.

1.6.1 Site selection, recruitment and training of environmental monitors

Environmental monitors and sampling points were initially selected during a desktop study undertaken by the researcher (Bannatyne, 2018). The researcher verified the sampling point using criteria that are discussed in detail in Chapter 4. Once the sites were verified, landowners or local leaders either gave permission to the researcher to find someone to act as monitor or the leaders or owners selected people for her. Once suitable candidates had been identified and contracted, the researcher, together with a translator, conducted training with monitors. During their training they are introduced to the sampling equipment

which includes a smart phone. This device allows them to communicate with the researcher and field technician (see Figure 1.1). The training was in two parts: the first part was about safety measures before sampling. The sampling training itself included instructions on how to sample and frequency of sampling. The training was done using a built-in form on the smart phone.

1.6.2 Managing environmental monitors

The management of the monitors was overseen by a field technician whose main purpose is to deal with the day to day administrative and logistical support for monitors. Including quality control, collecting samples, payments, and resupplying monitors with equipment. The field technician also has to maintain working relations while having to manage non-compliance of the monitors. The field technician deals with contract termination as result of funds running out, or as a result of misconduct. See Chapter 4 for more details.

1.7 Rationale for the Study and Potential Significance

This study has the potential value of improving citizen science within the Tsitsa Project and also in other DEA-NRM programmes, while also contributing to the literature in this field (which, as the next chapter will show, tends to be dominated by examples of voluntary citizen science). The overview of the literature, in Chapter 2, proves that citizen science is a valuable way of collecting data through working with community members. This study will try to understand why people participated in the data collection for the environmental monitoring initiative (what motivated them), how they perceived the actual benefits and how these benefits were enabled or constrained. At the same time, the host organisations' expectations and experience of benefits were also probed. It is hoped that insights will strengthen the citizen science projects in the Tsitsa Project and elsewhere in NRMPs in South Africa. This is important because DEA-NRM is looking to expand environmental monitoring projects nationally, and in the Tsitsa Project, monitoring is also set to expand in the form of community liaison officers.

To achieve new insights beyond what is already known, the research has to dig deeper and surface what lies beneath the actual benefits and how they are being achieved, or not. For this, a realist approach (Pawson, 2013) was applied, as explained in Chapter 3. This probes

not only the outcomes of an initiative, but also the underlying mechanisms that could give rise to these outcomes, and the diverse contexts in which this took place. As a field technician, I had observed that women were more reliable monitors than men, for example, and I wondered what the underlying mechanisms for this could be.

1.8 Goal of the Study

1.8.1 Research goal

The purpose of this study was to understand how best to work with monitors and how to optimise the benefits for all parties involved in the Tsitsa Project, with an emphasis on learning as a benefit of participation in citizen-based monitoring.

The research is centred around (1) the outcome patterns in the programme, specifically the benefits that the monitors and the host organisations (Rhodes University and DEA-NRM) did or did not gain from participation of citizens in environmental monitoring; (2) the underlying mechanisms that could have generated these benefits or absence of benefits; and (3) associated factors in the context of each individual and the programme as a whole, that could have played a role in the outcomes patterns observed. As an environmental education study, the two-fold overall aim was to inform the training and management of environmental monitors in this NRMPs, and to inform environmental monitoring programmes in general, as potentially important learning opportunities for the participants, government, and the scientific organisations that host them.

1.8.2 Research questions

1. What are the potential and actual benefits of the Tsitsa Project environmental monitoring initiative achieved for the Rhodes University staff?
2. What are the potential and actual benefits of the Tsitsa Project environmental monitoring initiative achieved for environmental monitors?
3. Why are potential benefits of the Tsitsa Project environmental monitoring initiative achieved, or not achieved?
4. What are the enabling and constraining factors (deeper mechanisms) within the Tsitsa Project environmental monitoring initiative?

5. Based on all the study findings, what are the educational recommendations for environmental monitoring in NRMPs and the Tsitsa Project?

1.9 Thesis Structure

Chapter 1 has provided a contextual overview of this research study, as well as an introduction to the Tsitsa Project and environmental monitoring initiative. A summary of the remaining chapters follows below.

Chapter 2 offers a review of the literature on citizen science in relation to this study. Citizen science in general is explored as well as specifically situated learning and environmental monitoring within 'Working for' projects in South Africa, using Kruger to Canyon as a case study (K2C).

In chapter 3 the theoretical concepts of realism are explained in relation to the study. This chapter also outlines the research design. Data generation methods (interviews and review of project documents) are discussed. The approach to data analysis is clarified, as well as validity, limitations and ethical considerations of the study.

Chapter 4 presents the research findings using the Context-Mechanisms (level 1 and 2)-Outcomes schema (with benefits being one of the major outcomes), constraining and enabling factors. This includes greater detail on how the environmental monitoring initiative was rolled out in the Tsitsa Project.

Chapter 5 discusses the research findings in relation to the research questions, using analytical statements, insights from the literature, and key recommendations to guide the discussion.

Chapter 6 summarises the whole thesis; it identifies key messages for decision-makers, managers, policy-makers, researchers, and implementers.

CHAPTER 2: Literature Review

2.1 Introduction

In Chapter 1 the history and contextual background to the study were introduced, along with its purpose, goals and research questions. As part of the background to the study, NRMPs were introduced together with environmental monitoring as a particular form of citizen science. This chapter reviews literature on citizen science with an emphasis on benefits and potential benefits. It briefly discusses literature on the reasons for citizens to participate in citizen science programmes, and recommendations for successful programmes. This is followed by a discussion on learning for all involved in programmes as one of the important benefits of citizen science. The realist theoretical framework for the study is also introduced. Finally, I discuss an example of an environmental monitoring programme, as a form of citizen science, in South Africa. This example shows the similarities between the paid form of citizen science and the globally known volunteer form of citizen science. In addition to providing important background to my study, this research also shows that voluntary citizen science might work in certain parts of South Africa where citizens have the ability to participate without any remuneration.

2.2 Citizen Science

2.2.1 Introduction

Citizen science involves the citizens involved in scientific data collection that allows scientists to study a variety of natural phenomena (as a general observation, it is foremost in the biological sciences where citizen science has been adopted as a method with the purpose of collecting observations in the field (Kullenberg & Kasperowski, 2016)). To achieve this, scientists work with non-scientists (citizens), some of whom can later formerly qualify as scientists (Bonney et al., 2009a; Eitzel et al., 2017). Citizen science covers a range of topics from astronomy, to the abundance and distribution of plants and animals, to air and water quality and public health (Bonney et al., 2014). Citizen science has the ability, with the help of participants, to collect large amounts of data to assist scientists in answering questions. Sometimes citizen science programmes also seek to influence learning through activities aimed at increasing knowledge of participants and/or adding to the literature

(Jordan, Gray, Howe, Brooks & Ehrenfeld, 2011). It can be influenced by disciplinary, geopolitical and language contexts. The following section explores the history of citizen science.

The section has sub-sections that introduce the history of citizen science. Following that is the section describing the field of citizen science and its characteristics. Following that is a discussion of reasons why citizens get involve in citizen science. Right after is a discussion about potential outcomes of citizen science, this describes outcomes that have been recorded and those that could be that is why it is followed by the benefits citizen receive from participating. Just before the conclusion a list of recommendations, from the literature, for running a successful programme.

2.2.2 History of citizen science

Citizen science is not a new term. It was coined in 1995 by Alan Irwin who described it as “a democratisation of science via citizen involvement in scientific dialogue and decision making” (Phillips, 2017, p. 4). Early on, Bonney (1996) described citizen science as public participation in scientific research through engagement with the scientific process that includes data collection, asking questions, and analysing and interpreting data. More forms of citizen science came later such as community science, crowd-sourcing, volunteer monitoring, community-based monitoring, participatory action research, and many more as listed by Newman et al. (2012) and more recently by Eitzel et al. (2017).

According to Silvertown (2009), citizen science existed even before science became a paid profession, as a feature of the early sciences like archaeology, astronomy and natural history. For instance, non-scientists have been contributing to research before citizen science became a recognised field; light house keepers reporting bird strikes in 1880; a national weather service cooperative observer programme which began in 1890; and the Audubon Society’s Christmas bird counting which began in 1900 (Bonney et al., 2009a).

Interest in citizen science grew exponentially in the 2000s and alongside this, interest grew in terms of funding projects for educators, social scientists, and evaluators in studying what learning takes place in citizen science, the mechanisms that foster or support learning and how to maximise the potential for learning in citizen science (Bonney, Phillips, Ballard, & Enck, 2016).

Citizen science has evolved in recent years because of protocols put in place by professionals in different fields (Silvertown, 2009). It is now part of a range of fields like climate change, the monitoring or control of invasive species, conservation biology, ecological restoration, water quality monitoring and other monitoring programmes. Possible reasons for the growth of citizen science include: 1. technology availability to disseminate and collect data, 2. realisation by scientists that the public represent a free source of labour, skills, computational power and finance. 3. funders require project leaders to conduct research-based outreach programmes (ibid.). Bonney et al. (2014) supports one of the reasons mentioned by Silvertown (2009) about the recent growth of citizen science projects has been enhanced by the introduction of technology into our daily lives. Technology like cell phones, computers and internet can engage a broad audience, motivate volunteers, improve data collection, control data quality and increase the speed at which decisions can be made. It also allows participants and organisers to communicate effectively. Bonney et al. (2009b) noted that technology can help include citizens previously excluded from scientific projects, but also that it requires sensitivity to social, cultural, economic and political factors as well as traditional local ecological knowledge.

2.2.3 Description and characteristics of the field of citizen science programmes

Citizen science means different things to different individuals (McKinley et al., 2017). Citizens can be involved in these programmes in a variety of ways and it is important to understand that there is not only one particular type of citizen science; there are a variety of ways. It is useful to understand the term as referring to a variety of types and degrees of involvement. Lewandowski and Oberhauser (2017) described citizen science as involving members of the public in conducting scientific research through collecting data. Eitzel et al. (2017) defined it as a way of learning about the world through activities performed by persons who are not scientifically qualified. The context of the research influences citizen science and can allow new forms to develop (ibid.). Wright, Underhill, Keene and Knight (2015) described it as an approach for integrating data collection across different geographic and temporal scales with community outreach, where members of the public participate in research and monitoring programmes. Programmes range from collection or monitoring ecological or environmental baselines, response to crisis and informing management actions. Citizen science can tackle local things and affect things globally.

Like other NRMPs in South Africa (discussed further in section 2.4.1 below), the Sediment and Restoration Group which is the focus of this study, adopted a variation of citizen science, in which the environmental monitors are paid for their contributions. While in much of the literature, citizen science is described as a process of volunteering, in the NRMPs in South Africa, the pattern is to employ people in an attempt to contribute to poverty alleviation and to build the skills in collecting environmental data (scientific data).

Both Bonney et al. (2009a) and Land-Zandstra, Devilee, Snik, Buurmeijer, and Van den Broek (2016) have identified different types of citizen science as follows: 1. Contributive where participants collect data for scientists with little other involvement; 2. Collaborative where scientists design the project but the public can suggest changes, and/or analyse and disseminate data; 3. Co-creation, when scientists work together with the public to address research questions or problems of common interest. In co-creative citizen science, participants are deeply involved at all levels of the research. Newman et al. (2012) supports that projects involve participants for one step while others involve them at different levels or multiple steps. Bonney et al. (2009b) in a Centre for Advancement of Informal Science Education (CAISE) report highlighted that collaborative and co-created projects have better opportunities to enhance benefits. Bela et al. (2016) suggested that co-design projects result in transformative learning. This does not always happen but when it does it may contribute to the development of an individual's skills. Table 2.1 summarises the different types of citizen science with their associated outcomes, based on the literature cited here.

Table 2.1: Different types of citizen science and associated outcomes (adapted from Bonney et al., 2009a; Land-Zandstra et al., 2016)

	Outcomes
Contributory	Technical skills
Collaborative	Highest knowledge of science content and process. Increase interest in science content, process and behaviour change
Co-created	Science enquiry, positive attitudes towards science content and process

2.2.4 Reasons for citizens to get involved

There are various reasons for participating in citizen science (Eitzel et al., 2017). These include providing data or help, contributing to monitoring and science, to becoming a social activist regarding environmental threats (for example, environmental champions (Ward, 2016)), interest, response to request, learning, social reason or asked by family member (Hobbs & White, 2012). Phillips (2017) identified six categories of motivation found in citizen science projects: 1. values (importance of helping others), 2. understanding (activities that fulfil a desire to learn), 3. social (influence by significant others), 4. career (exploring job opportunities or work advancement), 5. esteem (improving personal self-esteem), and 6. protective (escaping from negative feelings). An example from Wright et al. (2015) who studied birders in South Africa found five of these six categories. These were recreation, values, personal growth, and social interactions.

Phillips (2017) distinguished between reasons to participate and motivation. He/she identifies reasons to participate as the reasons citizens have or give for joining a citizen science programme, and they are usually associated with the actual benefits (see section 2.4.1.3), while she/he regards motivation as the reasons for remaining part of programmes. Rotman et al. (2014) found motivation to be initially driven by interest, self-promotion, and self-efficacy and feeling socially responsible. They also found that motivation was driven by the relationship with the project which created grounds for trust, recognition, mentorship and external relations (ibid.). Some participate to find like-minded people and for the opportunity to connect with nature (Bell et al., 2008).

In my study, I will compare the benefits mentioned, and potential underlying mechanisms, with the motivations found in the studies listed here.

2.2.5 Potential outcomes of citizen science

Although citizen science is mostly restricted to data collection, it can be a tool for collaborative research and the platform to co-produce knowledge between citizens and professionals (Eitzel et al., 2017). Generally, citizen science methods are simple but able to collect high quality data (McKinley et al., 2017). As Lewandoski and Oberhauser (2017) mentioned, citizen science projects have the potential to teach and provide an opportunity for the public to learn what a scientific project is about.

Edwards, Shaloum and Bedell (2018) demonstrated that involving school students as citizen technicians in participatory research can help improve understanding of the environment while gathering useful data. This example is focused on how involving the public can lead to awareness, knowledge gain and stewardship which in return could lead to a successful restoration programme. Similarly, learning about what citizens are involved in could lead to successful restoration. School children collect data and work directly with scientists, to understand the impacts of ecological restoration. Through this process the students' awareness and understanding of restoration was improved and that broadened the impact of restoration efforts. Students experienced an increase of environmental knowledge, awareness and stewardship through learning experiences, data collection and analysis, dissemination of results and direct interaction in scientists as pointed out by Bonney et al. (2009a) and Dickinson et al. (2012). Two more groups of researchers found that respondents perceived their environmental knowledge to be only moderate (both pre- and post-participation) indicating that concern about environmental issues is not necessarily matched by the perception of knowledge about those issues. Dickinson et al. (2012) states that the assumption that participation in scientific research creates authentic learning experiences, citizen science is also a powerful way to generate ecological knowledge, inquiry, and place-based nature experiences for the public. An example of a successful South African citizen science project that was focused on learning potential is that of the River Health Monitoring (RHM) Mini SASS (Stream Assessment Scoring System) which has developed into a networked learning initiative where citizens, including learners, can use the Mini SASS kit to monitor or assess the quality of the water or river and then report on their findings (Graham, Dickens & Taylor, 2004).

2.2.6 Benefits as a particular kind of outcome

This section describes the benefits for the different participants that are involved in citizen science which are a specific kind of outcome, i.e., a positive outcome. There is a wide range of benefits for all involved in citizen science projects (Raddick et al., 2009). Reed et al. (2010) have described the benefits. Benefits to the **scientists** include reporting measurements taken over long or very short time frames with large resultant datasets for analysis by scientists. Benefits to the **volunteers (citizen participants)** include enjoyment, social community, and ability to participate in science. Educational benefits are as follows:

opportunity for direct communication with scientists, increased content knowledge, an experience of the process of science and opportunity for changes in the attitude towards science (Jordan et al., 2011; Crall et al., 2012). For example, in a conservation project, citizens can learn about conservation issues and be encouraged to engage in conservation activities. Other benefits are personal enjoyment (having purpose), learning about the bigger picture, personal learning about the context they work in, helping, and contributing (Hobbs and White, 2012). Learning as a benefit will be discussed in detail in section 2.3.3. Benefits to **society** as a whole include closer connection between scientists and the public, as well as increase in scientific understanding and habits of mind by the public as a whole.

Figure 2.1 is an example of a framework for evaluation of citizen science programmes (developed by Jordan, Ballard and Phillips (2012) and modified in this study), which is based on the range of potential benefits. The figure presents three different types of benefits which can be achieved by the parties involved. The framework represents benefits (positive outcomes) for all the stakeholders. It also affirms that citizen science is not only for the benefit of scientists or researchers that need the data but there is a wider range of beneficiaries and societal outcomes.

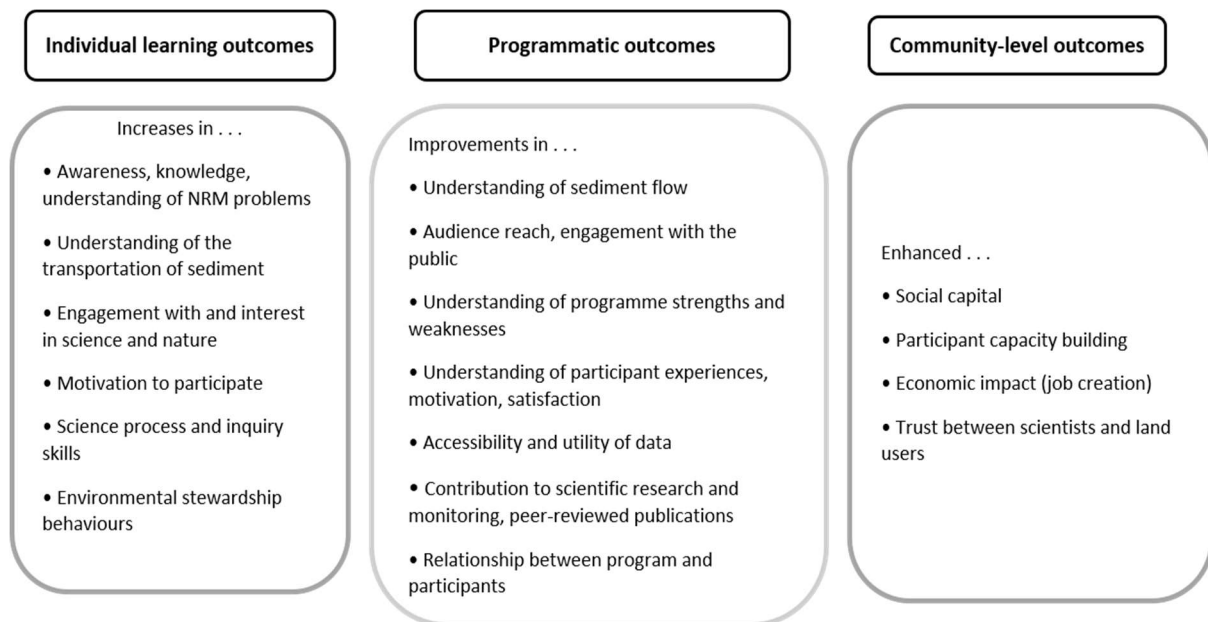


Figure 2.1: Framework with examples for evaluation of citizen-science programmes: positive individual, programmatic and community-level outcomes, i.e., benefits (modified from Jordan et al., 2012)

It is important to consider that in citizen science, motivation to stay or keep collecting data plays a big part in successful projects. In NRMPs there has been a debate on whether environmental monitors should be engaged as volunteers or paid employees. This is an important question, as citizen science could create employment, but payment could also reduce the intrinsic motivation to actively participate. Raworth (2017) discussed how the introduction of money can have both a positive and negative influence when it comes to being responsible for a common-good resource like the environment. The author argued that money has the potential of eroding social norms like pride. Once social norms are replaced by market (cash related) norms, it is difficult to reverse that effect (ibid.).

2.2.7 Recommendations regarding successful citizen science programmes

This section presents the recommendations made in the literature for running successful citizen science programmes. Better informed individuals have a better chance to deeply engage with citizen science (Bonney et al., 2009a). Newman et al. (2012) recommended fostering long-term community-level involvement activities, engaging under-represented audiences. Motivating people to contribute to citizen science projects requires effort and effective communication which consider both participant recruitment and retention for the long term (Dickinson et al., 2012). Retention can create a core team of participants with advanced levels of experience, providing local leadership, and resulting in more reliable data collection (Cooper, Dickinson, Phillips, & Bonney, 2007). Recruitment works better with existing groups or organisations that are effective and is better with local partners (ibid.).

Devictor, Whittaker and Beltrame (2010) created a framework (Figure 2.2) of how citizen science programmes should change in order for knowledge exchange to take place and to maximise benefits for all parties involved, increase knowledge and relationships, long lasting programmes and good data.

The framework (Figure 2.2) shows the connection between scientists and citizens from the question being asked to the educational outcome. This is similar to how the initiative is currently managed in the Tsitsa Project where scientists developed questions and protocols for collecting data. Scientists trained the monitors to collect good quality data. When the monitors have collected this data, the scientists analyse this to enhance their understanding

and learning. Participative approaches include both the citizens and scientists from the initial stages and both sides benefit.

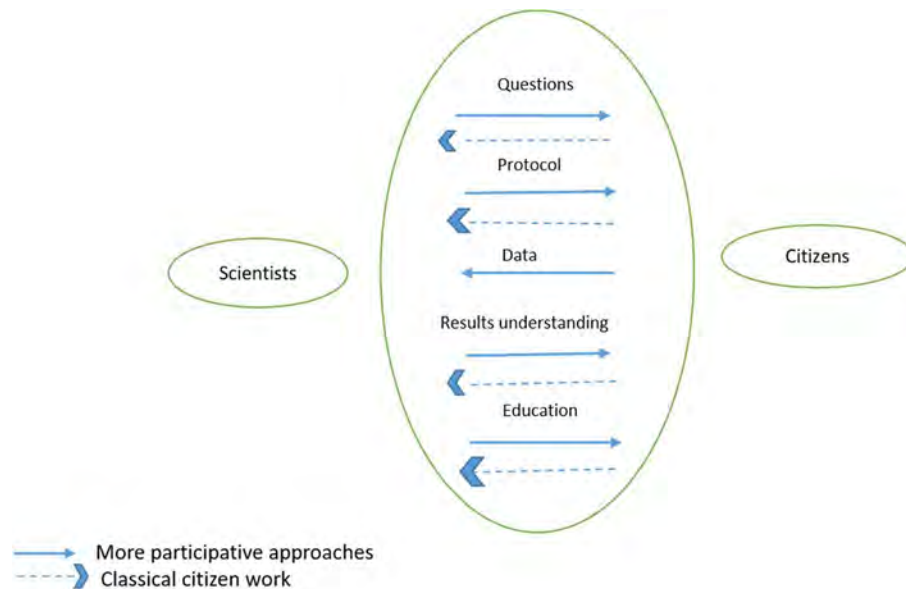


Figure 2.2: Framework for citizen science programmes (Devictor et al., 2010)

As my study will confirm, it is important for participants to be recognised as research collaborators to feel included and part of the bigger team (Raddick et al., 2010). To improve chances of learning, the programme must try to understand what participants learn about science content and process, and develop resources to maximise learning (ibid.). Lastly, it is important to understand *who* participates in citizen science programmes and what motivates them to participate at various levels of engagement (ibid.).

2.3 Learning

2.3.1 Introduction

Learning is one of the potential benefits of participation in citizen science processes, and it is a benefit that carries considerable weight for this environmental education study.

Therefore, it is discussed in more depth next.

Edwards (2006) defined learning as concerned with within-person changes, which modify the way in which we interpret and may act on our world, in turn changing it by our actions.

In the case of social learning, the learning of individuals also becomes embedded in

organisational and societal contexts (ibid.). The learning process of groups and individuals is embedded and influenced socially and cannot be separated from context. Brown, Collins and Duguid (1989) argued that learning is embedded in the immediate social and environmental context which is rich and diverse. Sfard (1998) also emphasised the importance for learning of being situated in social and cultural setups. This would be a key reason for studying the different contexts and social setups of citizen scientists, as these will influence the way they learn and potential benefits from participating.

There are many different forms of learning, and different ways of distinguishing between these various forms of learning. Phillips (2017), for example, distinguished between socially constructed and distributed learning; exploitative learning (an adaptive process taking place through the best use of what is known, to accumulate knowledge) and explorative learning (a process of experimenting with alternatives and introducing variation into a system) (ibid.). Phillips (2017) and Phillips, Porticella, Constan and Bonney (2018) have reviewed learning in the context of citizen science, thus the work of Phillips is used as the main focus for the introduction of learning below.

2.3.2 Learning in citizen science

A number of researchers have reported that not much has been documented (either in literature or reports produced by programmes) on increased interest shown in science or the environment, knowledge of science processes, skills of science inquiry, or stewardship behaviours (Bela et al., 2016; Phillips et al., 2018). The science community does not seem to value education or learning as the main outcome for their programmes. This could be as a result of the lack of measurability of learning in citizen science projects. It could also be due to the field being too young and therefore practitioners may not be clear as to how to foster learning through their programmes. Secondly, resources, time, and expertise in conducting social science research are lacking.

Phillips (2017) conceptualised learning at the individual level, which is most relevant to this study. Phillips et al. (2018) created a framework for articulating and measuring learning outcomes as one of the potential benefits (as mentioned in section 2.2.4) from participating in citizen science. This involves: 1) behaviour and stewardship which is described as behaviour change resulting from participating in citizen science projects; 2) skills of science

inquiry which include procedural skills like asking questions, designing studies, interpreting and disseminating data; 3) content, process and nature of science knowledge (this is the knowledge of the nature of science, scientific process and how science is conducted); 4) motivation to pursue science and environmental goals (like in environmental action activities) and get involved in citizen science project activities; 5) self-efficacy which is the extent to which learners have confidence in their ability to participate in science related activities; and 6) interest in pursuing science and environmental topics, careers, activities and issues. A few of these potential benefits have emerged in this study as presented in Chapter 4.

2.3.3 Theorising learning as situated learning

According to Phillips (2017), educational learning theories emerged in the mid-19th century. Among these learning theories are behavioural theories, where learning is conceptualised as a passive response to external stimuli. On the other hand, cognitive theories focus on more active constructing of knowledge and the processing that happens in the mind. Additionally, there are socio-cultural theories of learning such as the work of Vygotsky (Hall, 2007), which was further refined by psychologists and educational researchers like Engestrom, Wenger and Lave (Lave & Wenger, 1991), and Lotz-Sisitka (see, for example, Lotz-Sisitka, Wals, Kronlid & McGarry, 2015). The socio-cultural perspective describes learning as embedded in both social and cultural contexts. This means transformation of social practices happens at the same time as the individuals who participate in them. Therefore, the social and individual dimensions of learning are mutually constitutive (Boreham & Morgan, 2004), and learning is socio-culturally situated (Lave & Wenger, 1991).

Drawing on the socio-cultural school of learning theory, situated learning provides the lens of examining production and transformation of personal identities, practical skills and communities of practice through engagement with workplace and everyday life activities (Lave & Wenger, 1991). Learning is embedded within the lived experiences of the individuals as part of social practice (Phillips, 2017).

Researchers use situated learning in examining citizen science because it relates to individual learning, engagement and identity, beyond cognition and behaviour change. For example, Raddick et al. (2009) looked at the changes in involvement in various tasks as

leading to increasing knowledge and engagement within the community of an online citizen science project. Situated learning emphasises distributed learning that enables a learner to engage as a progressively more adaptive individual (Krasny, Tidball & Sriskandarajah, 2009). Lotz-Sisitka, Ward, Taylor, Vallabh, Madiba, Graham and Brownell (2018) found that learning and capacity building within citizen-based monitoring programmes was most effective when learning was situated in the social context of participants.

Situated learning is therefore suitable for this study because I am interested in the individual-level learning of the monitors in the context of their individual circumstances as Tsitsa residents, but also in their shared context of the river, sedimentation, land degradation, and the wider science programme, the Tsitsa Project, in which they are embedded as monitors. Given the importance of context in this theory, each monitor has been treated as a single case to study. Chapter 3 will elaborate on this.

2.3.4 Learning as a benefit of participation in citizen science

As outlined above, one of the key benefits of participating in citizen science is learning. Literature (Bonney et al., 2009a; Land-Zandstra et al., 2016) has shown that programmes involving co-creation have the potential to support learning as they provide a two-way platform which can lead to shifts in understanding. In the case of the Tsitsa Project, there are three levels at which learning could take place: monitors in their social context; monitors and managers; and the Tsitsa Project and NRMPs.

As noted earlier, learning among citizen scientists can take place through the opportunities for direct communication with scientists, increased content accessible scientific knowledge, an experience of the process of science (Jordan et al., 2011; Crall et al., 2012). Participants learn about scientific methodologies or ways to produce knowledge and the challenges of scientific research (Bela et al., 2016).

Learning is not limited to participants only; professionals learn to increase their methodological knowledge and their factual knowledge via data received from citizen scientists (Phillips et al., 2018). They also get data that has been put together to form verified local knowledge with the help of citizens (ibid.). In the process of running citizen science programmes, professionals can also learn how to be flexible and adaptive to case-specific circumstances which can lead to co-development and co-learning through

combining scientific language and citizen language. Scientists can learn to see the role of citizens differently, for example, not as anonymous or replaceable objects, but as holders of specific knowledge (Bela et al., 2016). Such knowledge about citizens' perceptions and values could lead to improved mutual understanding and relationships (Philips, 2017). This can create a comfortable and engaged working space between the scientists and citizens, and greater co-generation opportunities. The professionals get a chance to share the knowledge gained with a larger population through feeding it into a database and making it available for use in decision-making (ibid.). In the case of this research, environmental monitoring initiative managers can learn more about how best to implement environmental monitoring programme and also manage to share that knowledge with the rest of NRMPs.

The following section on environmental monitoring programmes will showcase capacity development as a specific approach to learning and focus in certain South African NRMPs.

2.4 Environmental Monitoring Programmes in South Africa

2.4.1 Introduction

This section introduces Natural Resource Management projects (Programmes) in South Africa generally. Natural Resource Management projects focus on job creation (see Chapter 1, section 1.4), with additional elements like training, skills improvement, data collection, and relationship building with communities for the host organisation (like Rhodes University). An example of NRMPs that work with monitors is Kruger to Canyon (K2C) which is discussed below. The intended outcomes of these are two-fold: poverty alleviation and taking care of the environment (<https://www.environment.gov.za/branches/environmental-programmes>). Expanded Public Works Programmes (EPWPs) with environmental monitors include Timbavati and Mnisi community programmes which have been reviewed by Swemmer et al. (2015). These are similar to the Tsitsa Project context (the Tsitsa Project is one of NRMPs) in that they hire citizens to undertake a variety of activities that are environmentally related and this is a form of providing some income for households, but it also has other benefits that will be mentioned in sections to come.

There are many NRMPs in South Africa but there is a shortage of research into their social aspects. Most research focuses on management and economic aspects, with social aspects being neglected in general. Abrahams, Sitas, and Esler (2019), in a review of peer-reviewed

articles published by Working for Water, reported that beneficiaries and livelihoods research constituted only 3.5% of the articles with the highest portion being biocontrol research at 34.5%. In research on one of the most long-standing NRMPs, the Working for Water (WfW) programme, only 5.9% of the work made it to publication platforms. Abrahams et al. (2019) acknowledged that ecological science was not sufficient on its own when dealing with challenges associated with implementing WfW activities. Broader literature under-appreciates social sciences and focuses on natural sciences but integrated research that works with social sciences is necessary for dealing with complex social ecological challenges (ibid.). This study feeds into this missing space by sharing the findings with NRMPs at large, increasing the literature on this matter. This study is also going to address social aspects. The following paragraphs provide an example of a DEA-NRM environmental monitoring programme funded project, K2C. I have focused on this programme because there are limited similar programmes recorded in South Africa, but also because my study took a case study approach.

The Kruger to Canyons Biosphere Region is located in the north-east of South Africa. It encompasses part of the Kruger National Park, as well as other national and provincial nature reserves such as the Blyde River Canyon Nature Reserve in the Mpumalanga and Limpopo Provinces. (https://www.environment.gov.za/branches/environmental_programmes). The K2C environmental monitors initiative was created as a result of unemployment in areas near protected areas and associated rhino poaching. K2C was established by DEA-NRM in 2012 and in 2013 the environmental protection and infrastructure programme took over the management of monitoring (Swemmer et al., 2015). Approximately 1 620 young South Africans participate in the environmental monitor programme (https://www.environment.gov.za/branches/environmental_programmes). There are 32 host institutions (seven public entities and 25 private nature reserves), with South African National Parks Biodiversity Social Projects as the implementing agent.

About 20% of environmental monitors employed in South Africa are in the K2C biosphere region. A noticeable feature is the extensive network of private and provincial reserves on the western boundary of the Kruger National Park, adjacent to subsistence farming and settlements of previous homelands (Swemmer et al., 2015).

2.4.2 Positive benefits

Swemmer et al. (2015) reported that the most significant impact about being employed at a personal level was the respect that was given to the environmental monitors by their families and community members. They appreciated being taught to be responsible individuals which has resulted in the environmental monitors feeling proud of themselves and having greater self-esteem and self-confidence. Being self-sufficient was also an important benefit, in the sense they could contribute towards the family's well-being (expenses, fixing things) and could participate in family discussions and decision-making.

The most popular part of the environmental monitoring job was perceived to be the knowledge gained from training (basic environmental monitors course offered by the South African Wildlife College), workshops about the environment and learning about computers. It was reported that formal training had helped participants to do their jobs more effectively, as well as empowered them for a positive future.

2.4.3 Negative outcomes

Although there are positive benefits, some environmental monitors reported that the monitoring job affected their daily duties, especially domestic duties. As a result, someone else had to do their chores. Some saw the change in their role in the family as negative because of having to spend more money on their families instead of themselves.

Learning seemed to play an important role in the monitors' enjoyment of the jobs. As reported, the least enjoyed jobs were the ones where they did not learn anything, or did not see the relevance or importance of what they were doing. Negative perceptions were noted at a broader community level in some cases, where environmental monitors had noted feelings of animosity and jealousy towards them from other community members once they were employed (Swemmer et al., 2015).

2.4.4 Reasons for taking the job

The most common response given for wanting the environmental monitor's job was simply needing a job for the income. The actual benefit was related to being able to help family with their needs and being self-sufficient, financial independence, building a home, gaining experience and exposure to opportunities, learning, confidence, saving for furthering studies, knowing more about and helping nature, saving money for kids, etc. (Swemmer et al., 2015).

2.4.5 Recommendations improving performance of environment monitors

Swemmer et al. (2015) made some recommendations for similar programmes as follows: motivate monitors constantly; train (have more accredited training that can provide proof of the skills acquired and experiences gained) and engage capacity building activities; provide workshops on communication (using the channels, manner of communication etc.); and have more contact with data collectors (or researchers) to align visions for the environmental monitors.

2.5 Conclusion

This chapter has provided an overview of literature relevant to the proposed study on environmental monitoring in the Tsitsa, namely literature on citizen science, citizen science benefits, learning as a citizen science benefit, and in particular the role of context in situated learning, as the framing that will be applied to the design and analysis of this study. The literature review is closed with a note about studies on NRMPs, and an analysis of one study found to reflect on a similar context and purpose as the Tsitsa Project, namely the K2C NRMPs.

The literature review suggests that the present study should fill a significant gap in the field, in the sense that there are few studies internationally that look at paid work as a form of citizen science, and few South African studies that look at monitoring as a component of the EPWPs and NRMPs. The literature review has however provided some pointers to the kinds of benefits that could be expected, as well as some useful analytical lenses, such as different types of citizen science processes, different types of engagement during citizen science processes, and different framings of learning. The theory of situated learning was found to be most appropriate for the Tsitsa Project context, and it points to a strong need to understand context and how it shapes learning (and potentially, other benefits derived from citizen science). This study will add to existing South African literature by looking at monitors' contexts (as individuals and the catchment). This will be further explained in Chapters 4 and 5.

Context is also an important consideration in critical realist evaluations (Pawson & Tilley, 2013) of social development programmes. The critical realist approach was chosen as the methodological framing for this study, which is outlined next (in Chapter 3), along with the process followed in undertaking the study.

CHAPTER 3: Methodology

3.1 Introduction

This chapter begins with a discussion of the research design including a realist framing and why a case study methodology was suitable for this study. The sampling method and selection of participants is also discussed, as are data generation methods which consist of semi-structured interviews, review of project documents and participant observation. This is followed by how data quality and validity were ensured. Data management and the analysis of the data is presented and the chapter closes with a discussion of ethical considerations.

3.2 Research Design

3.2.1 Research orientation: Realist framing

Critical realism recognises both the world as a physical reality and our experiences of it, and argues that both are important to research (Sayer, 2000). More specifically, critical realism differentiates between the real, the actual and the empirical (Sayer, 2000). There are two characteristics that describe the real: firstly, the real is inclusive of everything that exists (natural or social) regardless of our knowledge of it, and secondly, “the real is the realm of objects, their structures and causal powers” (capacities to behave in certain ways) (Sayer, 2000, p. 11). It is therefore a useful research philosophy that allows a researcher to go beyond the surface and beyond the actual (experiences patterned in sequence events) and the observed, to the causal mechanisms that are invisible (Sayer, 2000; Pawson, 2013). Pawson (2013) described the empirical as a combination of our experiences of the world, observations and perception that catch our attention. In this study, the monitors’ and managers’ perceptions of the benefits of the monitoring, are examples of empirical evidence.

As much as we can observe things like the structure of an organisation or a household, as well as what happens when they act, there are structures that may be hidden or not observable: “Observability may make us more confident about what we think exists, but existence itself is not dependent on it” (Sayer, 2000, p. 12). What is un-observable to us can be brought to existence by reference to the observable. Critical realism gives us a way of looking at the world and helps us explain it in greater depth as it also reveals the un-

observable. This is the reason for using the realist approach to help understand the environmental monitoring initiative within the Tsitsa Project, to answer the following research questions:

- What are the potential and actual benefits of the Tsitsa Project environmental monitoring initiative achieved for the Rhodes University staff?
- What are the potential and actual benefits of the Tsitsa Project environmental monitoring initiative achieved for environmental monitors?
- Why are potential benefits of the Tsitsa Project environmental monitoring initiative achieved, or not achieved?
- What are the enabling and constraining factors within the of the Tsitsa Project environmental monitoring initiative? (deeper mechanisms)
- Based on all the study findings, what are the educational recommendations for environmental monitoring in NRMPs and Tsitsa Project?

From a realist perspective, programmes are always embedded in contexts, that are active and open systems, involving social interactions that cannot be ignored (Pawson & Tilley, 2004). Kazi (2003) described programmes as open systems within which underlying mechanisms are activated to result in particular programme outcome patterns. Pawson (2013) supported this, saying that mechanisms ‘nudge’. These outcomes can be observed, meaning they are empirical; however, the underlying mechanisms (M) are often hidden from sight. They are nonetheless also real and worthy of studying. “The real exists regardless of one’s understanding of it (the world exists outside of our knowledge); in it there are a large number of objects, structures and powers” (Kazi, 2003, p. 805).

Realist research is not a particular method or a technical procedure but a logic of inquiry. In realist studies of programmes, the logic is that there is an underlying theory to the programme which can be improved, by answering the questions: what works, for whom, in what circumstances (contexts) and why? This understanding can be achieved through studying the underlying, interacting mechanisms that are associated with the programme, the contexts (C) under which these mechanisms function or ‘work’ and the pattern of outcomes (O) (Salter & Kothari, 2014).

Pawson (2013) described the context as an integral part of a programme. There are many layers that make up a context. Firstly, the individual layer includes the characteristics and capacities of the various stakeholders in the programme. Secondly, interpersonal relations are the stakeholder relationships that carry the programme. Thirdly, institutional settings are the rules, norms and customs that are local to the programme. Lastly, infrastructure includes the wider social, economic and cultural setting of the programme. The following paragraphs will elaborate on each, the context, mechanisms and outcomes.

Context describes the features of the conditions in which programmes like the Tsitsa Project's environmental monitoring initiative are introduced, that are relevant to the functioning of the mechanisms. It addresses the 'for whom and in what circumstances?' questions. Programmes with environmental monitoring initiatives, like Kruger to Canyon (K2C), are introduced into pre-existing contexts with social, historical, cultural and other features, which are important in the explanation of success and failure of programmes (e.g., whether environmental monitors collect accurate data regularly, or learn from their involvement). I have worked with environmental monitors in the catchment and observed the different contexts of these individuals. For example, some have responsibilities towards dependants and some do not, and that difference seemed to affect how these individuals worked as environmental monitors.

Mechanisms are described as a component of a programme that intervenes in the relationship between two other components (level 1), with the second type (level 2) of causal mechanism representing a relationship between programme components that is enabled, or conditioned, by a third factor (Dalkin, Greenhalgh, Jones, Cunningham, & Lhussier, 2015). Realism assumes that the natural world and social world are patterned and uniformities occur as a result of underlying order in the world that is discovered at the level of generative mechanisms (Pawson, 2013). Underlying mechanisms permanently exist even though they may not be exercised or realised (ibid.).

Mechanisms include, at the most visible level, the resources that are offered to enable the subjects to make the programme work (Pawson & Tilley, 2004). However, the resources need to trigger something deeper in order for a programme to 'work'; these deeper mechanisms include people's motivations and values, and even more deeply, social systems like patriarchy or colonialism which shape and interact with individual people's motivations

and values. Porter and O'Halloran (2012) noted that it is important to identify the different mechanisms at play to understand the outcome patterns observed. In the context of this study, environmental monitors were engaged differently by the managers; some were selected independently of traditional leadership and others were identified with the help of traditional leaders (for example). This study tries to understand the deeper mechanisms through the intended benefits expressed by the host organisations and the monitors, and the associated values. Factors in the context, such as the presence of children or other dependents, may be associated with mechanisms (such as an individual's sense of responsibility) which could be activated by the monitoring programme.

In my research I have identified different levels of mechanisms as follows: the first level is the mechanisms the programmes introduced, i.e., the selection, training and management of the monitors; the second level is those mechanisms that were triggered in the monitors and these are realised by identifying the way the monitors reacted to the first level of mechanisms.

Outcomes or outcome patterns are a result of the interactions between the various individuals' contexts and both the level 1 and level 2 mechanisms (Pawson & Tilley, 2004). Outcomes patterns are formed by similar outcomes that occur repeatedly. Mixed outcome patterns involve intended and unintended consequences (ibid.). Programmes are studied for the explanation of why the outcomes developed as they did and how the programme would react under other mechanisms and in different contexts (Kazi, 2003). This research will focus on whether, how and for whom the intended benefits (outcomes), as expressed by the environmental monitors and the host organisations (Rhodes and DEA-NRM), were achieved. I am considering benefits as one of the outcomes for both monitors and the host organisation but this does not mean that it is the only outcome the research will focus on.

There is no standard formula for how programmes affect outcomes without context playing a big role. Therefore, investigation of linked configurations of C-M-O is important and so is the use of multiple methods of data collection (Salter & Kothari, 2014). Multiple methods, both qualitative and quantitative, can be used to understand C-M-O. It is important to understand the context and mechanisms in order to explain the different outcomes for the different monitors. Figure 3.1 shows the interaction of C-M-O as explained above, especially in the section describing context, mechanisms and outcomes. Figure 3.2 shows how the

C-M-O methodology has been applied in my study with regard to the Tsitsa Project. As explained above, the Tsitsa Project arrived with the citizen technician monitoring initiative in the context of monitors with its own mechanisms that in turn would interact with underlying mechanisms to produce outcomes.

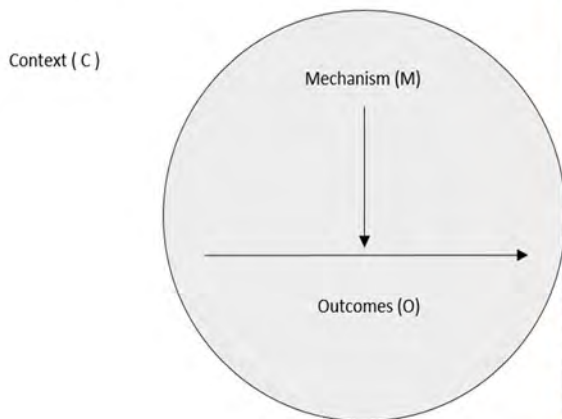


Figure 3.1: Classic realist C-M-O configuration (Pawson & Tilley, 1997)



Figure 3.2: Realist configuration within this study (based on Pawson, 2013)

The final outcomes do not offer a full explanation of the outcome patterns that are associated with the programme but function at a ‘middle range’ with the use of concepts and data between the description of implementation and hypotheses of universal theory (i.e. abstract generalisations) (Salter & Kothari, 2014).

There are two reasons for the selection of this realist lens. While this study is not an evaluation of the programme, the realist methodology of studying context, mechanisms and outcome patterns in relation to each other helps explain what has worked, for whom and why (Kazi, 2003). It helps explain how the programme’s causal mechanisms interacted with other casual mechanisms in relation to monitors (and their contexts) and the Tsitsa Project (ibid.). The ‘why’ component is important for this study because it is trying to find out why the benefits were achieved or not achieved. Did monitoring ‘work’ for the individuals and organisations concerned, did they get the actual or potential benefits, or not, and why? Secondly, the realist lens emphasises the context as one important component. In this study it is important to look at the individual contexts because situations are likely to be different and may have influenced the different outcomes I have observed in the programme. Yet, if

we can identify underlying mechanisms that might be similar for a range of individuals, we could make recommendations that can be applied more widely, possibly even on a national scale. Realist methodology allows the researcher to propose a generalisation across different cases and contexts, even when the sample size is small (Sayer, 2000).

3.2.2 Qualitative case study approach

A realist approach uses different methodologies. In this instance I have chosen a qualitative case study methodology. Many theorists have defined case studies. Yin (1994), for example, has described case study as descriptive and explanatory. Stake (1994), in Sada and Maldonado (2007), identified three types of case studies: intrinsic (understanding of a specific question), instrumental (a way to improve understanding of an issue) and collective (which is a collection of single studies to provide a more complete picture). My study is both descriptive and explanatory, and it seeks to understand outcomes rather than test theories; it is therefore an intrinsic case study.

A case study approach was chosen because it was important to get some depth and rich data on each of the environmental monitors, individually, and their contexts. Each monitor was treated as a mini case study. Case study tools are preferred for answering the who or why questions (Yin, 1994). These are used to focus on a contemporary phenomenon within some real-life context (ibid.). Fourie (2016) stated that case study tools investigate and report on the complex dynamic and unfolding interactions of events, human relationships and other factors in a unique instance. The Tsitsa Project is dynamic and unique and so are the circumstances or context of each monitor; therefore, a case study was suitable for my research questions.

In this research the overarching aim is to understand the ways in which citizen science (in the form of environmental monitoring) can best be implemented in natural resource management situations (specifically, in the first instance, the Tsitsa Project), with emphasis on training and capacity or skills development. This requires an in-depth look into the context, what is happening empirically but also digging deeply into the lives of the environmental monitors to understand the reasons that have led to the way they experienced and worked in the Tsitsa Project. It is important to ask the why and how

questions at every angle to uncover the personal, social, and environmental factors that enable or constrain the environmental monitors in their work.

Case studies provide a view of real people in real situations, enabling readers to understand ideas more clearly than simply by presenting them with abstract theories or principles (Sada & Maldonado, 2007). They observe effects in real-life contexts, recognising the context as a powerful determinant of both causes and effects (*ibid.*), and both level 1 and level 2 mechanisms. Level 1 is the component of a programme that intervenes in the relationship between two other components, and level 2 represents a relationship between programme components that is enabled, or constrained, by a third factor (Dalkin, Greenhalgh, Jones, Cunningham, & Lhussier, 2015). This is why a case study was suitable for the realist approach used in this study.

3.3 Sampling and Research Participants

The study site was predetermined by where the initiative's work is based (more than one village and some private land), and therefore so was the selection of participants. As mentioned in Chapter 1, originally there were 11 sediment monitoring points in the Tsitsa River catchment, Ntabelanga area. That number grew to 16 when the Lalini catchment points, along the Inxu River, were opened for a year. Each monitoring point has/had (since some have been closed) a single employed monitor who had to also find a stand-in. During the course of the project some monitors were either retrenched (for various reasons), some needed replacing, and some sampling points were closed permanently as a result of financial constraints and having collected enough data from the points.

I aimed to involve all past and present monitors in the data collection but for safety reasons decided that two monitors should not be part of the study. Specifically, I excluded E18 and E19 because they were problematic monitors. Both these excluded monitors are from the Lalini catchment which was closed. For this reason, my sample was reduced from 20 to 18 monitors, but only 17 were ultimately included because one monitor, not residing in the catchment any longer, could not be reached on the phone. This number was made up by nine females and eight males.

All managers were interviewed in person (see Box 1.1). There were no challenges related to finding the managers: one DEA-NRM official and four Rhodes University staff (including one intern and one field technician) who are involved with the monitors programme.

3.4 Data Gathering Methods

3.4.1 Introduction

For this research I made use of qualitative research tools to construct the case study. Qualitative tools are used to study people or systems by interacting with and observing the participants in their natural environment and focusing on their meanings and interpretations (Maxwell, 2008). Qualitative research emphasises the quality of data and not the quantity or amount, which is why it does not require many participants (*ibid.*). Three methods were used for data collection in this study: semi-structured interviews (asking questions and listening to the answers), observing events (also self) as participant observer in the project (and noting carefully what happens) (Bassey, 1999) and reviewing programme documents.

3.4.2 Interviews

Interviews are one of the qualitative data collection methods that are primarily used in case study research (Gillham, 2000). There are four types of interviews (Sada & Maldonado, 2007): informal conversational, semi-structured, standardised open-ended and closed quantitative interviews. For this study I chose semi-structured interviews because they gave me an opportunity to probe responses, while focusing the conversation around the research objectives of the study (Frey & Fontana, 1991). According to Puri, Watson, Newing, and Eagle (2011), semi-structured interviews are pre-arranged interviews based on a prepared interview guide (a list of questions to be covered). In this study, the interview guide was used as a checklist to make sure that key points were covered.

Interview methods are useful in that the presence of the interviewer can help clarify queries from the respondents and can stimulate the respondent to give full answers to the interviewer, rather than an anonymous researcher known only through an introductory letter (Gill, Stewart, Treasure & Chadwick, 2008). As interviews can be flexible, questioners are able both to probe and explain more fully (Doody & Noonan, 2013).

However, the very features that make interview methods attractive may also make them problematic. For example, an interview may be affected by the characteristics of the interviewer positionality (e.g., gender, race, ethnicity, personality, skills, social status, clothing and appearance). They may also be affected by the conduct of the interview itself (e.g., rapport between the interviewer and the interviewee), and interviewees may be reluctant to disclose some information if they feel that the interview will not be anonymous or if sensitive information is being requested.

I had to be aware of these issues and took the following steps to mitigate against them: I reminded interviewees that I was not the field technician anymore and asked about the current field technician to put them at ease. I found that my positionality was not a significant challenge because participants already knew me and we had a good relationship. My interviews did not involve asking participants for sensitive information and there was no need to hide any information. (See p.46 for more on my positionality and validity of findings.)

I conducted 17 interviews with environmental monitors, five initiative managers (two researchers, two managers and a field technician). The interviews were conducted in the form of conversations with the participants, with the help of a schedule. The interviews were conducted in the language the participants were comfortable with, therefore both English and isiXhosa were used depending on preference. The length of interviews ranged from an hour to an hour and half. An audio recorder was used to record the interviews which were later transcribed. The data was first captured in Microsoft Word via transcription, and later into Microsoft Excel after coding the transcripts.

The interview schedule (which was also translated to isiXhosa) (Appendix 1) was informed by the information uncovered during the review of project documents. I set up one-on-one meetings with selected environmental monitors (past and currently working), the Rhodes University staff and DEA-NRM officials as outlined in the sample, i.e., managers. In most instances I drove to the monitors' homes at an agreed time; this way it is easier to create rapport. They chose the venue which was most comfortable and convenient to them. Three of the monitors that were retrenched were not in the catchment anymore and therefore an interview was conducted over the phone. Because I had been a field technician (see Chapter 1) I had a good working relationship with most of the monitors, except for ones that joined

the project after I had left. In general, there was a good rapport and I managed to gather rich information. Occasionally I only got monosyllabic answers and I realised that me having been a field technician may have intimidated some interviewees.

3.4.3 Observations

Puri et al. (2011) described observation as a relatively unstructured interaction method for studying people as they go about their daily routines and activities. In this study observations happened during engagements with the monitors. These observations helped me to be able to understand why some monitors behaved in certain ways.

When I worked as a technician, I took detailed observation notes in my field book and these proved to be a valuable source of information for the study. Participant observation research methods are an integral part of being a field technician. I captured notes about my engagement with the monitors during this time and that knowledge was important and added value to the reports used for this study. I used to monitor how the monitors worked, visit their personal space every month and sometimes interacted with individuals around specific issues.

Bernard (1994) defined participant observation as the process of establishing rapport within a community and learning to act in such a way as to blend into the community so that its members will act naturally, then removing oneself from the setting or community to immerse oneself in the data to understand what is going on and be able to write about it. Observation methods are useful and I was able to observe how monitors responded to the project and that knowledge assisted me to interpret interview findings. I observed, amongst other aspects, the distance from sampling sites and the context in which the monitors were working.

3.4.4 Review of project documents

Documents can be interpreted by a researcher to gather relevant data. This is a useful first step, in my study, to understand where the project comes from and where it is at present, and involves becoming familiar with existing knowledge. This includes reasons for the Tsitsa Project, its intended benefits, contextual information and the programme's mechanisms, i.e., project documents review allowed me to draw on the knowledge of the documents I looked at. The documents described the programme and provided me with information I

could take into the interviews. For this study, these are the documents that I reviewed: Tsitsa Project documents, such as research investment strategy (Fabricius, Biggs, & Powell, 2016), internal Tsitsa Project reports (including field reports by the field technicians), research papers (Cockburn et al., 2018)), theses from two students (Nyamela, 2018 & Bannatyne, 2018) that were using the monitoring data, and the field guide document from when I was a field technician. From these documents I gathered data on the research questions and information that helped me prepare for the interviews.

3.5 Reflections on Field Work Processes

Social realists practise reflexivity in their research, explaining their position and influences explicitly and how this could affect the results of the study (Mantzoukas, 2005). As Mantzoukas (2005) noted, keeping an open mind as researchers should not be equated with having an empty head. Reflexive studies are meaningful only if the researcher can use the virtues of previous experience, expertise, knowledge, language and expectations to design, interpret and present the research findings critically and reflexively (ibid.). The following section shares some challenges and issues during the data collection period.

I intended to interview 18 participants or more, four from the Lalini catchment and 14 from the Ntabelanga catchment, but ultimately only interviewed 17 because one monitor was not living in the catchment any longer and could not be reached on the phone. Two of the 15 interviews took place over the phone because the participants were not in the catchment during the time of the interviews. They were either retrenched or their contracts had ended. I made two trips into the catchment where I had one-on-one interviews with monitors in their respective places of residence. Monitors chose a meeting place, always at their homes and none missed our appointments. Phone interviews were difficult, however, for various reasons (discussed below).

I had a few challenges including monitors being busy with their current jobs which resulted in them being unable to meet at arranged times. The phone interviews were difficult due to bad reception or out-of-date phone numbers. One was not interviewed due to a combination of the above-mentioned challenges.

The more I conducted the interviews, the clearer the conversations went. I learnt to be flexible and not restricted by the schedule of questions; rather I used them as a guide. One

of the challenging aspects about one-on-one interviews was the distance to environmental monitors' homes. They are widespread across the catchment and I typically drove 1-2 hours for a single interview.

Some participants did not seem interested in answering questions and simply gave short yes or no answers. Sometimes probing worked but I did not want to push too much. Lack of facial expressions and body language could be challenging and I could not always tell when a participant was uncomfortable or not willing to answer questions.

3.6 Data Management

An index code identification system was introduced at the beginning of the study so that every piece of evidence to a specific person could be linked with ease (Fourie, 2016). Index coding is a method for keeping track of data so that it can be accessed quickly (ibid.). The same number and letter combination index code was used for interviews. Table 3.1 shows the index codes and the data from the interviews which allowed me to create anonymity.

The data was in the form of interview transcripts, observation notes and Tsitsa Project documents. The interview audios and transcripts were backed up on a Google drive, as well as consent forms (see Appendix 2); both are password protected. Observation notes and project documents are stored on three devices (two hard drives and personal computer) and will be transferred to the central Google drive, to allow for the checking and revisiting of raw data, for example for future publications.

Table 3.1: Index codes used to identify participants in the study

Type of respondent	Index code
Staff of the Tsitsa Project programme (managers)	S1-5
Environmental monitors	E1-17
Ex-monitors that were excluded	E18-19

3.7 Data Analysis

The data collected in the study was analysed using qualitative analysis approaches. This was primarily based on coding. Coding is a systematic form of annotation that involves marking

sections of the text with standardised codes that indicate the themes they touch upon (Puri et al., 2011).

The first step involved coding, following the C-M-O methodology, of the interview transcripts (these were printed) using different colours. Saldana (2013) called this the first cycle of coding, structural coding, which collates similar pieces of data, according, for example, to a question, for more detailed coding and analysis. This coding cycle involved standardised colours that were captured at the top of each transcript for a particular method. They helped in the second stage of the analysis (building of the conceptual framework (Puri et al., 2011) The second cycle coding was what Saldana (2013) called pattern coding which is where I identified similarly coded data and organised these into an Excel spreadsheet. This involved arranging the coloured pieces into a spreadsheet according to the colours and following the C-M-O framework. The colours helped identify the context, mechanisms and outcomes from the interview sheet. Data from the reports written by the field technicians and observation notes were also captured onto the same spreadsheet. Following this step, summaries of each case were written. Lastly, a table that summarised the general context, mechanisms and outcomes for all monitors was created. Outcome patterns emerged from the stories as presented in Chapter 4. I went on to distinguish between Level 1 (operational) and Level 2 (deeper) mechanisms as described by Dalkin et al. (2015). As described in section 3.2.1, the first level consists of the mechanisms brought by the programme into the monitors' context. Level 2 (deeper) is how the monitors responded to level 1, or what the programme triggered for different monitors.

Another method of analysis applied in this study involved creating diagrams as a sense-making tool to help synthesise data. Diagrams of the C-M-O were produced representing the general population of monitors in the Tsitsa Project, and then this was used to summarise two embedded cases. Bazeley (2009, p. 13) reported on the value of displaying data to develop the researcher's understanding: "The researcher moves from describing to explaining, through abstraction".

Two embedded case studies were selected after the analysis was completed, to illustrate the range of experience of the monitors who had received the same treatment but with different outcomes. The embedded cases are examples of two particular environmental monitors which highlight their different experiences and outcomes. An embedded case

study refers to a case that is embedded within a larger case study (Scholz & Tietje, 2002), as with this study.

3.8 Data Quality and Validity

One indication of validity is whether the instrument measures what it is expected to measure (Fourie, 2016). The interview schedule was piloted in order to make sure questions were not unclear, ambiguous, or leading the interviewee in a particular direction biased by the researcher. Further, the structure of the schedule was scrutinised to ensure that no prior questions could unduly limit the participant's responses. All interviews were recorded using an audio recorder. The purpose of the audio recording was to assist the researcher to remain true to what interviewees said as the data was fully transcribed. Recording the interviews and being able to replay events is an effective form of improving data quality. After the data was transcribed and analysed, it was taken back to the participants using different formats. A meeting was held with the participants, all together, still in the catchment and messages were sent to those outside the catchment. This was done to give participants a chance to approve, change or edit interpretation of the data. Following the data collection and data analysis phases, I held an informal feedback session with all the available monitors. A feedback session is planned with the managers once the thesis is complete. This helped facilitate a comfortable space where monitors could share their experiences with each other and the team. They agreed with the data captured.

To not compromise the validity of responses I did not impose my preconceived ideas by, for example, asking leading questions, and I did not pressurise interviewees into answering when they did not feel comfortable. Mostly importantly, I informed the Tsitsa Project managers that the study was not an evaluation to highlight their flaws but rather was an attempt to understand the programme better. With the monitors, I made sure to create a trustworthy space by starting the conversation on a light note, for example, reminding them about how the participants knew me and ensuring the monitors knew that I remembered them. Mostly importantly, I informed the Tsitsa Project managers that the study was not an evaluation to highlight their flaws but rather was an attempt to understand the programme better. My understanding of the isiXhosa language, customs and culture helped give deeper insights.

Although I was previously employed as a field technician, I am confident that my positionality did not affect the data collected. If anything, it was easier to conduct the interviews because people could relax around me, unlike if a stranger or a new person was interviewing them.

Collecting data via phone calls may have been a bit problematic in that it is difficult to gauge how someone is feeling or see their facial expression but I made sure to use follow-up questions as much as I would have with face to face interviews. I noted that I got similar engagement with interviewees whether it in person or over the phone. The fact that I had an existing relationship of trust with the people I was interviewing face to face or over the phone helped to ensure that I could collect valid data.

3.9 Ethical Considerations

3.9.1 Introduction

There are several reasons why it is important to adhere to ethical norms in research. First, norms promote the aims of research such as knowledge, truth, and avoidance of error (Resnik, 2011). Second, ethical standards promote trust, accountability, mutual respect, and fairness. Third, many of the ethical norms help to ensure that researchers can be held accountable to the public (ibid.). Ethics are set to protect the research participants from any harm. Similar to those outlined by Resnik (2011), Rhodes University requires that the following principles be adhered to: respect and dignity (the aim of my research was not to use my participants for my benefit only; there are bigger benefits that could assist them or others in different programmes). I respected participants and treated their contributions honestly and accurately. I was also aware of how respect applies differently in different contexts (for example the university and the rural context); transparency and honesty (I was always honest about the study and obtained participants' consent); accountability and responsibility (I made sure participants knew they could hold me accountable and it was my responsibility to treat them ethically); integrity, academic professionalism and researcher positionality (discussed in section 1.2)

(https://www.ru.ac.za/media/rhodesuniversity/content/institutional_planning/documents/Research_Ethics_Policy.pdf). This section discusses how the participants gave consent, how I tried to keep everyone anonymous, how permission was acquired from gatekeepers and participant feedback.

3.9.2 Consent

Informed consent is not a moment but a process (Fava & Sonino, 2009). It occurs in the relationship between researchers and participants – rather than in the documents produced for the records (ibid.). Informed consent is needed because participants have a right to choose whether to participate in the research or not, after being well informed about facts that could affect their decision (Sada & Maldonado, 2007). The criteria for consent include competence (mature individual), voluntarism (agreeing to participate voluntarily even when there are risks), full information (the participant is fully informed about the research and the risks) and comprehension (participants fully understand the nature of the project) (ibid.). Taking account of these four aspects, the researcher can be assured that the participants' rights have been considered. Participants should also be clear that they are not going to be rewarded for participating (e.g., paid or penalised for not participating)

Participants in this study were asked to read and sign a consent form (see Appendix 4) which was translated in writing for the isiXhosa first language speakers. For over the phone interviews, the consent was recorded with an audio recorder. In some cases, I read the consent form for the participants, especially the ones that did not have a smart phone to receive images. The consent form included: the purpose of the study, content and procedures of the research; any foreseeable risks and negative outcomes; benefits that might be derived from the research; incentives to participate and rewards from participating; right to voluntary non-participation, withdrawal; rights and obligations to confidentiality and non-disclosure of the research, participants and outcomes; opportunities for participants to ask questions about any aspect of the research; and signed consent for participation.

Participants were asked to sign the consent form. Those that were interviewed in person had a chance to read the consent form and ask questions and for the phone interviews, the form was read to them in their home language and the consent was recorded and saved with appropriate security and confidentiality onto a hard drive and the cloud.

3.9.3 Anonymity

The essence of anonymity is that information provided by participants should in no way reveal their identity (Sada & Maldonado, 2007). I coded the interviews using anonymous

codes, therefore even the people that know the monitors will not know which monitor said what. All participants agreed to be thanked in the thesis. Although I know who had provided the information or was able to identify participants from the information given, the connection will not be made public in any way; information provided is treated as confidential. Although I have discussed the findings with my supervisors, they were generally not aware of the identity of the monitors. They also agreed to confidentiality. Everything participants told me was equally respected and accepted as the truth because I had created a safe and trustworthy environment.

3.9.4 Gatekeepers

Gatekeepers are individuals or institutions that act as intermediaries between a researcher and the potential participants, with the power to give or deny access to carry out the intended research (Clark, 2011). The gatekeepers for the monitors are the traditional leaders, who are the customary authorities in the Tsitsa catchment (see Chapter 1). I had been working with the monitors before, as explained in Chapter 1, and had good relations with the traditional leaders. Therefore, it was easy to set up a meeting with the relevant traditional leaders to inform them about my work and about 'being in their backyards'. The farm workers in the study were interviewed with the permission of the manager or farmer who employed them. No harm was done or resulted from the research in the area.

3.10 Conclusion

This chapter presented the methods used to collect, manage and analyse data. The data was collected using two forms of qualitative data collection methods: semi-structured interviews and observations, with reviewing of project documents to assist the formation of the interview schedule used as a guide for interviews. Observation notes that were captured in a field notebook assisted with understanding certain outcomes that emerged during the analysis stage. The data was analysed using the C-M-O framework with the help of colour coding. Chapter 4 presents the findings which will follow the same format. This chapter also presented the research orientation, sampling and how research participants were selected, data quality and validation as well as ethical considerations.

CHAPTER 4: Findings

4.1 Introduction

This chapter will present the findings that emerged from the analysis of data collected by means of the research techniques described in the previous chapter. An overview of the findings is given in the form of a table (see Table 4.1). This is followed by two embedded mini cases, after which benefits are presented for both Rhodes University and monitors. Following this is a description of the mechanisms and the context as identified from the findings. The chapter concludes by describing enabling and constraining factors for environmental monitor programmes (initiatives). Information in this chapter is focused on this specific programme's wider relevance to Chapter 5.

Table 4.1 presents a summary of the findings according to the context, mechanism, outcomes (C-M-O) format. The general context as described in Chapter 1 and as each case will show, is a rural one with cases situated in the former Transkei area (i.e., a former homeland during the Apartheid era). Most of the monitors employed by the environmental monitoring initiative were previously not employed. They are predominantly females who are married with families. The level 1 mechanisms are those that the project introduced in the form of recruitment, aptitude tests, training and management. The level 2 mechanisms are the deeper, underlying mechanisms, which are not shown in the Table 4.1 but are discussed in the narrative below (see section 4.4.3). The outcomes, which are presented as positive outcomes (i.e., benefits) and negative outcomes, vary from the obvious (financial gain) to the less obvious (including self-efficacy, pride and self-esteem). Negative outcomes include concerns about data by the managers, and jealousy and interference from neighbours experienced by monitors.

Table 4.1: Summary table of main findings related to the experience of monitors and Rhodes University staff in the environmental monitoring initiative, highlighting context, mechanisms and outcomes

Context	Mechanisms (Level 1)	Outcome
<ul style="list-style-type: none"> ● Gender: most are females, females are married, males are single ● Family and living arrangements: females mostly have children; young males also mostly have children but the mothers care for the children; young men all live at home with family; women have own homes and are staying at home (no work) ● Education: mostly high school level ● Socio-economic status, income, employment: most were unemployed to start with; most are dependent on husbands or other family members or social grants for income/living costs ● Location: all are currently resident in the catchment with some residing on farms as workers and the rest in communal areas; Ntabelanga: most live close to the river; Inxu: most lived far from the river ● Crime: for example, gangs affecting people's ability to collect samples; substance abuse leading to petty theft and concerns about equipment safety 	<ul style="list-style-type: none"> ● Paid work is on offer – so people want to participate ● Site selection: sites were selected on a biophysical basis; monitors were appointed based on their proximity to the site, i.e., how close their house is to the river ● Recruitment method: 1. Direct selection based on location; 2. Selection via local leadership (traditional leader/councillor) – thus related individuals usually favoured: means of identifying candidates, even before aptitude test ● Aptitude test: candidates were screened based on performance in the test (to determine their ability to collect samples) ● Training: explanation of working conditions and MOA (contract), theoretical, practical and safety training and introduction to equipment: rules and regulations/ terms and conditions ● Ongoing management of monitors: interactions with university managers, remuneration, data quality control, equipment maintenance, oversight of work performance, relationship management and communication and ongoing support, problem management / troubleshooting, termination of contracts or dismissals 	<p>POSITIVE: Managers</p> <ul style="list-style-type: none"> ● Scientific data ● Economic development: sent money to the catchment ● Skills development: trained technicians ● Environmental awareness ● Learning <p>POSITIVE: Monitors</p> <ul style="list-style-type: none"> ● Income and resultant independence, improving household comfort and quality of life, and ability to support family ● Learning about the environment/their surroundings (river and sediment transportation) ● Increased interest in the river and good memories of the work ● Technical skills and career development ● Sense of purpose, contributing to something bigger and helping others, liking working ● Keeping busy and having a structure to the day ● Increased self-efficacy, confidence, pride and self-esteem <p>NEGATIVE: Managers</p> <ul style="list-style-type: none"> ● Insufficient data ● Challenges of working with people (e.g., constraints to recruitment because of traditional leader); context-related challenges; funding challenges); no available reliable candidates ● Equipment problems (e.g., exacerbated by distance to catchment) <p>NEGATIVE: Monitors</p> <ul style="list-style-type: none"> ● Jealousy and interference from neighbours or community – pressure to share opportunities ● Disruption to daily life/lifestyle ● Problems with stand-ins (relationship issues)

4.2 Embedded Cases

4.2.1 Introduction

Two mini cases were selected to be presented in this section. The embedded mini cases are two examples of environmental monitors which provide nuanced illustrations of the main findings of this research, as they highlight the different experiences and outcomes for two specific monitors. The two monitors lived a few kilometres away from each other but in different local municipalities and under different traditional leadership (different rules/clans/norms, etc.). The two local municipalities are Elundini and Mhlontlo Local Municipalities; the latter is well known for a high level of crime. This context may have some bearing on the monitors' circumstances and life experience.

4.2.2 Case 1 – An enterprising but unreliable young man

Case E10 is a single male who at the time of working in the project was living at home, looking after his brother's house, but mostly simply staying at home. Though he has been allocated a site by the traditional leader but has not built a house on it yet. He had planned to build but this plan fell through when he lost his job with the Tsitsa Project as a monitor. I present him as a mini case study because he was the most unreliable environmental monitor (Bannatyne, 2018) and usefully illustrates the challenges experienced by both monitors and managers in this initiative. E10 has fathered two children (aged 11 and six) who are taken care of by their mothers. E10's highest level of schooling is Grade 10, as he had to quit school because he was epileptic at the time. He gets along with his mother but not his father. He has four siblings from his mother and three from his father.

I now discuss the way in which E10 was recruited as a monitor. At the very early stages of the Tsitsa Project when the team was searching for environmental monitors, E10 had just come back from Cape Town where he was working as a contractor. He mentioned that he was "*taking a break*" because life in Cape Town was hard, and he had quit his job because he was not happy with the way in which the boss treated him: "*the white person we were working for was not paying us well so I thought I should go back home and catch a breather*". The researcher from the Tsitsa Project approached him while he was watching soccer with a friend. The researcher was white and spoke English; the friend did not speak or understand much English and this seems to be the primary reason why E10 was chosen. The researcher explained that she was looking for

someone to help her collect samples and E10 agreed to assist. He felt he was lucky to get a job in the rural area after having trouble in Cape Town, and therefore decided to stay rather than return to Cape Town. Like all monitors involved in the project, E10 was informed of the purpose of the project which was to measure the sediment in the Tsitsa River and its tributaries in relation to the proposed dam. The researcher left promising to come back at a later stage.

As promised the researcher and a translator returned with equipment which included a cell phone. E10 was trained on how to sample (see section 4.4.2.4). During the training the researcher told him to 'imagine floods' in order to help him practice which resulted in a misunderstanding. He continued to sample imaginary floods because flood samples paid more money (refer to section 4.4.4.1 and table 4.2), thus he collected samples during non-flood times and passed them off as flood samples because he says he was told to 'imagine' the floods. He did, however, also collect good samples during actual floods. He did not recall writing a test but remembered a piece of paper that listed the equipment. It was during this visit that the researcher lost her personal phone and E10 helped her to recover it. This is relevant because it showed that he cared and looked after the people from the Tsitsa Project. He mentioned this because he felt the people he cared for did not reciprocate this care.

Although he sampled good floods, that is, he took the high frequency samples required during a flood event, his baseline flood samples were not good. i.e., he did not collect samples consistently during non-flood times (Bannatyne, 2018). This pattern of behaviour (outcome) has been explained by E10 himself as due to the fact that the high frequency flood sampling meant more money. E10 had a different approach to money compared to the majority of women who participated in the study, as will be seen below.

Further attesting to his unreliable behaviour as a monitor is the fact that he lost two project phones (which are essential for sending data to the university, as will be described in section 4.4.2.7). The next paragraph will explain how he lost the phones. Additionally, he did not communicate about his absence at times he had agreed to be available for visits from the field technician; this was particularly inconvenient due to the large size of the catchment which therefore involved considerable distances to be travelled for meeting. He asked a younger brother (under age) to act as a stand-in. During the holidays in which traditional ceremonies took

place (this includes initiation school, communicating with ancestors, etc.), he missed many samples as he enjoyed drinking when attending these.

E10 lost his first work phone to theft (taken from his house). His mother reported that the second phone had been taken by a loan shark because E10 owed him money. The loss of the second work phone without an explanation led to his dismissal from the monitoring initiative. He reported that he was not happy with how the team, especially the researcher, dealt with this issue. After several attempts to have a meeting with him at the local traditional leader's house, the team had to hire someone new and organised for the equipment to be collected. E10 did not understand the involvement of the traditional leaders at this stage; he felt disrespected by the team he had respected when taken to the traditional leaders' house. He would have preferred an opportunity to talk before the traditional leaders were involved. After this event he decided to go back to Cape Town because he did not want to be regarded as 'laughing stock' in the area.

E10's unreliable monitoring outcomes can be linked to his disposition to rules and authorities as mentioned above. He disregarded traditional leadership and its way of doing things, as is evident in the following quote: *"I am used to being in courts, do not tell me about Imbizo¹".*

E10 noted that as a result of the team having gone to the traditional leader, a sub-headman came to tell him that *"akukhomntu apha kuwe (you are useless)"* and that the monitoring job should have been given to their children (sub-headman's and the community members that reside in the catchment). E10 admitted that he had been invited to a meeting at the traditional leader's house three times but did not go for various reasons, which included being busy with *umgidi* (welcome home ceremony from initiation school for boys) and then later he decided he did not like the approach. Before the incident, certain community members were annoyed that he had got a job having only recently arrived from Cape Town.

Because of his erratic sampling and the loss of the project phones, he received one verbal warning and two written warnings from the field technician and was finally dismissed as a monitor after the second phone went missing. The manner in which the dismissal took place reveals some of the intricacies of recruiting and managing monitors and will be discussed in some detail below.

¹ *Imbizo* is a gathering of traditional authorities with community members to discuss matters of the community, including crime, behavioural problems and others.

The monitors' relationship to money is important because it speaks to what motivates environmental monitors. E10's disposition towards money can be detected from the following interview findings: When he got the job, he expected to get experience. He also realised that the job was easy, that one could potentially earn a lot of money, and that there was no one to monitor him all the time. He had realised that flood focused sampling made him more money (payment is per sample, refer to section 4.4.4.1 and table 4.2) and so he made sure to do this well – to the point of also sampling imaginary floods. The main source of money for his house came from his father. He mostly used money for buying himself clothes, giving some to his girlfriend, some to pay debts, and lending money to siblings in Cape Town. He appreciated the positive benefits that came with the job as he could support his children, look after himself, make his girlfriend happy, and help his mother with groceries. He appears to be a self-sufficient and enterprising individual as he managed to get another job as a security guard as soon as he moved back to Cape Town.

E10 expressed an interest in the lab work process claiming this would help him understand the purpose of the monitoring job better. He claimed that he understood that information gained from his work would help advise building of the dam. Although he did not see the direct benefits for Rhodes University, he knew they were benefiting the most because environmental monitors worked hard for them and he also thinks that government benefited, but he felt that environmental monitors were intentionally kept in the dark in this regard. He did not see any benefits for the traditional leaders or the community though he had linked the project to the dam which could be beneficial both for the people and the environment.

He had good things to say about the team from Rhodes University managing the initiative. For example, he thought the Tsitsa Project was doing a good job in trying to improve rural areas and worked well with people (he felt he was treated well) and kept promises (including depositing money on time). He admitted that he had sometimes been in the wrong, but no one ever disrespected him. He emphasised that bosses need to respect their employees because without them the job cannot be done and the boss cannot get paid. He recommended that the way in which he was reprimanded and eventually dismissed, should not happen to someone else.

4.2.3 Case 2 – A responsible, hard-working mother of three

The second embedded mini case study, E6, was chosen because of different outcomes from E10, and to illustrate positive experiences of committed monitors leading to positive outcomes for herself and the initiative. E6 was a housewife (she was involved in day-to-day household management, church activities and immediate family commitments). She was married to a local man working in Pretoria (at the time of data collection) and had three children, two of whom went to school and one had dropped out. They owned a home. Her highest grade was 11 because she chose to get married which was important at the time as the husband was always the main provider. E6 was active in the community, serving on several committees including the school board and traditional council.

Her motivation for becoming a monitor can be seen in the following section. When the researcher approached her (refer to section 4.4.2.1), E6 was scared of taking the job (mainly because the researcher was white) but agreed because she was the closest to the river. Although she was the closest to the river, she still was 25 - 30 minutes away which has been reported as a challenge when it is flooding as it is too far to walk home with no shelter, especially when the river is high. But when the river is not too high, E6 sits under the bridge for shelter from the rain. E6 agreed to help, when other people were not interested, because she had engaged with white people before the arrival of the researcher; she felt sorry for the researcher and realised that whatever she was trying to do, must be important to her.

Despite the importance of the income to her, E6 also grew to love the job, somewhat surprisingly. Despite her initial discomfort with working with a researcher who was white, and hoping that perhaps she might not return as planned, ultimately she signed a contract when the researcher returned with a translator which helped E6 to relax. Training started at home, then she was taken down to the river for some practical experience. She worked well except despite a few challenges: she received one verbal warning for using the phone for personal purposes and two written warnings for missing samples, one of which was due to death of family. E6 was ultimately one of the most reliable monitors in the project, and much can be learnt from her case.

Regarding E6's relationship with money, before the job her main support was her husband and money from the children's government grants (social welfare grants). The project changed this for her and gave her something to do with her time. In addition to the benefit of money, she started

enjoying the job. E6 enjoyed the cash income but also learned to monitor the rise and fall of the river which made her interested in the water. She also checked the samples when they have settled at home noting differences in the sediment. She used the money mainly for her daughter who is in school in Cape Town. Sometimes she bought herself clothes and food. She was surprised that she learned as much as she did from the project.

She was aware of the benefits from her work in the initiative going to the government and to Rhodes University but she did not see any benefits for the community or the traditional leaders and associated benefits towards the environment with the fixing of dongas (a steep sided gully that is created by soil erosion) which in return limits the amount of water going into the river.

Other benefits which E6 noted included not being part of the village gossip as she did not have time for this. As a result of earning her own income, E6 reported that sometimes she told her husband not to send her money as she could manage to support her family. She has grown to love the job so much that she 'feels lonely' when not sampling and as if something is wrong. E6 reported that sampling helped her pass the time and that she planned her day around it, i.e., it provided structure to her day.

Unlike the situation with E10 where community members felt others should have got the job, the community did not have a problem with E6 working because they understood that she was the closest to the river. However, at the beginning people were scared of crossing the bridge when she was doing flood sampling as they were suspicious of her sitting there and were unaware of her work. She enjoyed answering questions from curious individuals. She had hopes of receiving a certificate at the end from the job.

As part of her closing remarks she mentioned that older people have to work for what they get: "They are still acting like children, someone else takes care of them. Us elders, you have to work for what you get." E6 was responding to my trying to understand what makes women or older people more reliable than the young men that were part of the project. It appears that the more family responsibilities a person has, the more reliable they are as environmental monitors.

4.3 Benefits

In this section I will present the benefits for the DEA-NRM and Rhodes University, along with those of the environmental monitors. Following an overview of the benefits, actual benefits achieved are considered as well as those that were either potential or unattained.

4.3.1 Benefits for monitors

4.3.1.1 Overview

In general, it seemed true that the monitors valued money as it allowed them to improve their circumstances or purchase things. However, I was surprised that it was not only the money that was important to people. Some continued to go to the river even after they were dismissed and people missed other aspects besides the money. For example, some missed carrying around the equipment like the two litre containers. Visible equipment was significant because it showed that a person was working and it made others curious when they spotted a monitor wearing a life jacket, etc. This indicates that other benefits were derived beyond the more obvious ones related to income.

4.3.1.2 Actual benefits achieved for monitors

As assumed by the managers and researchers, money or what the citizens called "*imali yamanzi*" (river money) was the most important reason for getting involved and it motivated some monitors to carry on working well. The monitors reported that money assisted in various ways. It helps them support their livelihoods, themselves and their families (e.g., children's education and buying food). The money allows monitors to buy clothes and household items such as kitchenware (stoves, kettles, fridges and pots), general household items (cupboards, headboards, televisions, blankets, washing machines, beds, etc.) and enabled them to join a 'stokvel' (women's group that saves money for the end of the year's expenditures, especially Christmas). For some, the money helped support other businesses. For example, E12 managed to buy herself a sewing machine and the start-up material for a sewing business, while E1 managed to revive her clothes selling business (see box 4.1). For some monitors (mostly the younger ones), the money helped improve their confidence because they could contribute financially within their families. E4 stated that "*yandenza umntu (I became a person)*" – the money enabled some young monitors to become more independent as they did not have to ask for money from their families any longer and they could keep their girlfriends happy.

The few who claimed to have used the money wisely, with an emphasis on no drinking of alcohol, mentioned visible structures like building a house, buying a rainwater tank, flattening a yard. When asked about participating in 'pure' citizen science work for the sake of the work itself, some monitors said they would not collect water samples for free or if they did, they would not be as dedicated because they did not see how participating would benefit them.

There were some interesting, less tangible benefits mentioned like managing time so well that there was no time to gossip (mentioned as a positive), planning days around sampling and that this job gave them something to do, i.e. a sense of purpose. Monitors reported that they had learnt about the change in the river and some stated that their interest in the river had increased, as they came to understand sediment transportation and soil erosion. For example, E9 noted that *"it made me much more aware of how the river works and all the changes and influence it has got on the banks ... big water and dry times. So, it made me much more attentive of my natural environment as such."* Most environmental monitors had a good understanding of the purpose of the sampling (*"You guys told me that they want to check the amount of soil (ntlence) in the water when the river is low and when it is high"*).

Information sharing helps raise awareness amongst other local people and the monitors themselves through asking questions and trying to understand the purpose for sampling.

The environmental monitors expressed their feelings towards the project using words like "enjoyment", "liking it", "loving it"; "feeling lonely when not sampling" and some environmental monitors felt "lost" without it (a sense of losing meaning). Most commonly mentioned was that the job was very easy once one understood it.

There were some other surprising benefits mentioned, especially from those that were no longer monitors. Some stated that they liked the safety clothing and equipment like gumboots, life jacket, carrying the sampling equipment and being involved in the sampling process in general. Those introduced to smart phones for the first time by the project claimed they enjoyed using the phone and having it in their care. Some continued to go to the river when it had rained and reminisce or take random pictures as they had done when they were working. For example, E1 said: *"I usually go to the river when it has rained and think of the times I was working there."* Physical well-being was one of the things the environmental monitors missed from doing the job.

E7 said *“Walking to the river helped me with exercise”*, and E2 said *“Since I was not used to waking up early, it was good for me.”*

There were also personal benefits which included the friendships that were created with the researcher/field technician/other monitors. Like E9 said: *“I think the friendship, I call that a benefit. I got to meet a lot of interesting people from the university. It’s inspiring to see people that work on projects that are relevant and that can change a lot of things for good.”* Some mentioned that being part of the project inspired them. Those who had never had a job came to believe in themselves realising they could both hold a job and do it well. Lastly, the monitors appreciated the shared respect between themselves and the field technician and the researchers.

4.3.1.3 Potential benefits for monitors and other catchment residents

The project has the potential to raise further awareness. Currently the project does not have direct benefits for the traditional leaders and the community at large. There is no feedback of data analysed back to the monitors and they are not engaged in the process.

4.3.1.4 Unattained benefits

A few environmental monitors did not mention any form of learning emerging from being part of the project. Among some there is lack of understanding of the bigger project while others have no interest in knowing about this, as long as they get paid for the work they do.

Because this was an everyday job, some environmental monitors missed out on activities that used to take them away for weekends. For example, E8 mentioned that *“I cannot go to church since I started working in the project. My church travels a lot to places that are far.”*

At its start the project did not have a structure for engaging with local leaders or anyone about hiring environmental monitors. As a result, the hiring process differed from site to site. For the majority of the sites, the process resulted in good monitors, with a few exceptions, for example, E18. The lack of protocol for engaging people was a mechanism that had good and bad outcomes.

One thing not reported much but evident from my field observation notes, was the jealousy expressed by some community members towards environmental monitors. Sometimes it even created tension between the monitor and the community. For example, E7 mentioned that *“They used to say that I should rotate with someone, or give the job to someone else because I have been getting a lot of money ... that I should allow someone else to taste the money.”* Although

some individuals were evidently jealous, others admired the monitors' jobs and were interested in taking part.

Certificates as a form of proof of experience were expected by some of the younger monitors as these are useful when applying for other jobs. They commented that this would provide more tangible evidence that could help to create a pathway to other work.

4.3.2 Benefits for DEA and Rhodes University

4.3.2.1 Overview

For the Rhodes University staff, the most important intended benefit, initially, was to collect sediment transportation data as quickly and cheaply as possible; S5 stated that *"the objective was very much focused on getting data as quickly as possible. Sediment data."* The researchers never regarded the catchment residents as the primary beneficiaries; people were simply the means to get to as many sites as needed at a much cheaper rate than permanent probes positioned in the river, and with less risk of expensive sampling equipment being destroyed by natural disasters or by locals who do not understand their purpose. For DEA-NRM, however, it was important to have money going into the catchment in the form of payments going towards the residents, i.e., they were motivated by an interest in shared benefits between Rhodes University and monitors from the start.

It is evident that data was important to the Rhodes University staff as it helped answer their research questions. From the host's perspective, this research was also meant to benefit other role players like government and catchment residents, but only in the longer term. An additional value to the researchers includes potential publications and qualifications from the research.

The next section explores how the Rhodes University staff have gained much more than data being collected. As S1 said: *"I think I learned, in being in such a large project, it's important as well as to understand across boundaries and liaise across boundaries ... to not try and be everything to everyone, that you do have certain core tasks, everybody in the project has certain core tasks."*

The following sub-sections present three kinds of benefits for the host: actual (tangible benefits), potential (benefits the Rhodes University staff have identified as a possibility) and unattained (benefits they did not receive or even consider).

4.3.2.2 Actual benefits for the Rhodes University staff

As mentioned above, the most common actual benefit identified by the Rhodes University staff was receiving data collected by environmental monitors, although the data was not always of the best quality in terms of what the researcher needed. *“It’s about the two sides. We have to do science, so it’s not just about collecting data, it is about getting good quality data and building that knowledge.”* ‘Data’ refers to information gathered from water samples collected by monitors. Based on the data, Rhodes staff learned about suspended sediment data processing and how landscapes work biophysically in terms of erosion and sediment transport.

Rhodes University staff also gained a better understanding of rural livelihoods. S1 stated she now has a view of *“what it’s like to live there and who the people are who live there”*. They also reported being able to pronounce and get to know names of the environmental monitors and becoming familiar with the landscape. The Rhodes University staff felt they had gained some experience in managing people, data, quality and time. As S1 stated: *“it was a big eye opener in terms of people management and data management and quality management.”*

Furthermore, Rhodes University staff noted that they had learned to teach people about the scientific methods used to collect the samples. Other benefits for staff included gaining social skills and being able to liaise across boundaries. They also noted having learned about responsibility, driving, communicating between various kinds of people in general and learning more about the Tsitsa Project. Rhodes University staff gained problem-solving skills and built relationships and trust with the environmental monitors. The Rhodes University staff reported that they had grown in confidence, independence and had changed in practice from being idealistic to being much more realistic and flexible.

Finally, the project has gained ‘a face’ in the Tsitsa catchment, as S4 said: *“I think that’s quite important because we now got a face to a project and people can link to that face.”* ‘Having a face’ implies there is a person representing the Tsitsa Project on the ground, for example during field trips with funders and project advisors.

4.3.2.3 Assumed benefits for the monitors

The Rhodes University staff had certain assumptions about what the environmental monitors used the money for. They assumed that the money helped to increase income for some homes. It

provides the environmental monitors with the ability to improve their livelihoods, paying for children's education, with steady income.

Other assumptions that would need to be verified included skills transference from the Rhodes University staff to the environmental monitors in the form of technological familiarity through their use of the phone and gaining experience. Some monitors improved their numerical skills through the numbering involved in labelling the samples. Time management was another benefit as monitors needed to sample but could not neglect their daily activities. As will be supported by the following section, monitors gained knowledge from sampling. According to S1, *"I have learned everything about suspended sediment data processing, background, the whole thing, the scientific side of it as well."* Rhodes staff assumed that monitors gained an understanding of their area and the dangers of soil erosion and how the landscape works from a biophysical perspective.

4.3.2.4 Potential benefits for the Rhodes University staff and DEA-NRM

This section presents the *potential* benefits of the initiative noted by the Rhodes University staff. Firstly, there was the potential (not yet achieved) of useful knowledge exchange between the researcher(s) and the monitors; information sharing should not be one way and knowledge should be shared with the residents in the catchment. Secondly, Rhodes University staff felt that having an office in the catchment, with a local coordinator, would assist with gathering data on the ground whilst it is still 'fresh' in the monitors' minds. S4 said: *"You need to be available quite often to correct things and to answer questions. Exchange equipment and various things have happened with where we store equipment, like just that, like suddenly people tell you they are closing an office or the whole business closes down."*

On more than one occasion managers reported a lack of engagement with the environmental monitors. It was suggested by S5 that spending more time with the monitors could assist in avoiding challenges with regard to data quality, especially for new monitors. She gave the following example: *"For example, the numbering problem for E5. When we were there, he could do everything perfectly and then over time, it turned out that he had a counting problem. That is something we could have identified if we were there for a while after we had trained them but we didn't see."*

There is a potential benefit of monitors learning more about changing practices in the landscape so as to reduce erosion; however, this was not achieved, because there had been no intention or

effort on the part of the Rhodes University staff to share this kind of information with the monitors.

The major negative outcome is that arising from 'out-migration' of monitors in the lower catchment. When monitors leave, for various reasons, they leave the initiative without a replacement monitor in place. Another challenge is related to the loss or damage of electronic equipment by monitors, for example E10 who lost two phones.

This is not to say that the monitors did not produce data that was good in some parts and poor in other parts, but as S1 stated, the initiative *"failed to achieve suspended sediment sampling to the extent that we would have liked it to have done."* Poor sampling, that is missing floods and/or baselines and sampling at wrong intervals, contributed to the poor quality of some of the data. Unreliability of monitors further contributed to poor data production.

4.4 Mechanisms and Context

This section presents the data in the form of the context which delves into the monitors' context in general, and their more specific individual context. This is followed by the level 1 mechanisms that were introduced by the project, after which are the underlying mechanisms (level 2) that were unearthed by level 1 mechanisms.

4.4.1 Context

4.4.1.1 Introduction

Pawson (2003) described context as an integral part of a programme. There are many layers that make up a context. Firstly, the individual context is the characteristics and capacities of the various stakeholders in the programme. Secondly, there are interpersonal relations which are the stakeholder relationships that carry the programme. Thirdly, institutional settings are the rules, norms and customs that are local to the programme. Lastly, there is the infrastructure or the wider social, economic and cultural setting of the programme. Pawson (2003) further noted that contextual layers are infinitely complicated, intertwined and in motion.

Here context is discussed for its possible influence on the outcomes of the citizen monitoring process. This is of interest in order to plan for scaling up or scaling out citizen monitoring in this or other contexts. I break the context down into the context of individual monitors, which differ

somewhat, and also analyse the influence of the context of the catchment as a whole, as there were contextual features shared by all monitors.

4.4.1.2 Individual context

Most environmental monitors were females that were either married or had children and/or other family to take care of. They stayed at home with their families and often had no other forms of income except for a few that received remittances from their husbands or child grants in some cases. Living conditions were 'normal' for the region (i.e., they were not well off but not very poor) for most of these females except for two that were living below the poverty line, have no income or any prospect of jobs. One was relatively well educated and never stopped chasing her dreams (this is the reason why she left the project) and the second had to leave in order to look after her mother and her children.

The least responsible of the environmental monitors was male (see the case of E10). Only one male was married with a family and the rest were young males that lived with family and had children with different females (except for one).

Education levels generally went as far as high school (Grade 10-12). There were various reasons for not being able to carry on with education, with lack of money and schools being the most frequently mentioned reasons. There were exceptions: some managed to study beyond Grade 12 either through support of their families, bursaries or loans.

As a result of not being able to further schooling and being based in a rural area where there is no prospect of jobs, any work was welcomed, whether people were desperate, curious or simply needing the money. They felt lucky to have something come to them while they were at home; E10 said: *"I was also lucky to get a job that came straight to me while I was here"*. E8 mentioned that *"I liked the fact that the job was here in my village and did not have to leave my parents without someone to take care of them and cook for them"*.

Being a responsible individual equates with being a reliable monitor. At first I hypothesised that married females with families were more reliable than young unmarried males. This was true for the most part because all the women that were/are environmental monitors were either married or single with children and family while the young men might have had children but were living at home with parents still taking care of them. The general findings when comparing genders was that females worked well and were able to communicate if something went wrong. Males

seemed to have other commitments that made them miss samples. One exception was E13 who never missed samples without a valid reason. When asked what made him (E13) different, his response was: *“I think it’s the way one behaves (indlela yoziphatha).”*

4.4.2 Level 1 mechanisms

4.4.2.1 Introduction

Mechanisms are portrayed as the underlying processes that link programme elements and activities to specific programme outcomes within particular contexts and drive programme success and changes (Pawson, 2000). Mechanisms are discussed here because they help to understand what could have led to the outcomes. Different levels of mechanisms have been identified: at the first level (operational), the recruitment, training and management of the monitors; at the second, personal circumstances, deeper cultural and personality factors, which will be discussed below in section 4.4.3.

The following sub-headings have been adopted from the document guideline for the *Planning and Implementation of a Citizen Technician Based Suspended Sediment Sampling Network* by Bannatyne (2018, v1.2). Chapter 1 briefly introduced this process.

4.4.2.2 Site selection criteria

Site selection was largely based on a desktop study by the researcher. After this, a field trip led to locating identified sampling points and houses nearest to the sampling points with potential candidates. Sites had to satisfy the following criteria: availability of at least one person to be employed as a monitor; located a short distance from the monitor’s dwelling; bank conditions that would be safe at all water levels (e.g., no overhangs, no likelihood of cut-off by rising water); and sites away from areas that are used regularly by locals (Bannatyne, 2018).

4.4.2.3 Sediment field technician criteria and roles and responsibilities

The main purpose of a field technician is to deal with the day to day administrative and logistic support of the monitors. The administration of samples included quality control and compliance checking. Field technicians had to:

1. Assist in identifying monitors, recruiting and the initial training;
2. Undertake periodic field visits to pick up samples and resupply of equipment and consumables;

3. Use the Open Data Kit database to observe daily and during field visits to check sampling procedure compliance;
4. Provide day to day support and communication; and
5. Support all aspects of monitors' payments for samples collected and provision of airtime and data (Bannatyne, 2018).

The sampling equipment and protocols required to provide the data must be determined and assembled by the researcher together with the field technician. This process includes the field administration, sample tracking, Open Data Kit download forms, problem solving, and payment. Field administration included photographing the book in which monitors record data, checking the book, checking that all samples exist, downloading Open Data Kit forms, resupplying monitors with jars, and exchanging equipment or planning to do so.

4.4.2.4 Identification of monitors

After the first field trip, ownership of private land was identified to get permission to work in the area and in communal areas, the relevant traditional leaders were identified. Traditional leaders were not fully involved initially but were approached at a later stage. The custodians of the land were involved in the identification of suitable candidates. Traditional leaders either gave permission to the researcher to find someone or they selected a person for the job; in some areas more than one candidate was suggested. The candidate had to be able to communicate, read or write in English and be able to use a smart phone. An aptitude test was used to assess potential candidates. See Appendix 3 for an example of the aptitude testing form. This was given to most monitors during the first meeting with the initiative team. If there was more than one person then the highest scoring person was offered the job but they did not always want it. The ones selected directly or singled by the local traditional leader out were not tested as there seemed to be no point testing one candidate.

The main challenge for the selection was the availability of people capable and willing to help, the distance to the sampling point (some points were very far from homesteads), and sometimes the pre-selection by the traditional leaders. On privately owned land, there were only a few or no people that were not already fully employed to work on the farms.

4.4.2.5 Sampling training

Monitors mentioned that having a translator that spoke isiXhosa helped them understand things better during training. A training document was given to each monitor to use as a reference. The document provided step-by-step instructions for both baseline and flood sampling. Emphasis on the different time protocols for baseline and flood sampling is important to achieve good results. Table 4.2 shows the sites and sampling times in times of floods and also demonstrates how some monitors earned more money from flood sampling. Figure 4.1 shows the sampling points listed in the table for Ntabelanga catchment.

Table 4.2: Ntabelanga catchment flood sampling routine

Site name	River name	Flood duration (estimated hours)	Sampling timing and frequency
Hlankomo	Hlankomo	1-3	every 10 mins
Cornlands Farm	Little Pot	1-3	every 10 mins
Lokishini	Tsitsana	1-6	every 15 mins
Thembekeni	Gqukunqa	1-8	every 15 mins
Maclear	Mooi	6-48	1 st 10 samples: every 30 mins, 2 nd 10 samples: 1 hourly
Vipan farm	Pot	6-56	1 st 10 samples: every 30 mins, 2 nd 10 samples: 1 hourly
Tsitsa Falls	Tsitsa	6-56*	1st 10 samples: every 30 mins, 2nd 10 samples: 1 hourly
Junction Ferry	Inxu	12-60*	1st 10 samples: every 30 mins, 2nd 10 samples: 1 hourly
Tsitsa Gorge	Tsitsa	12-60*	1st 10 samples: every 45 mins, 2nd 10 samples: 1.5 hourly
Qulungashe Bridge	Tsitsa	12-60	1st 10 samples: every 45 mins, 2nd 10 samples: 1.5 hourly
Mbelebushe DWS weir at Xonkonxa	Tsitsa on N2	24-60	1st 10 samples: 1 hourly 2nd 10 samples: 2 hourly

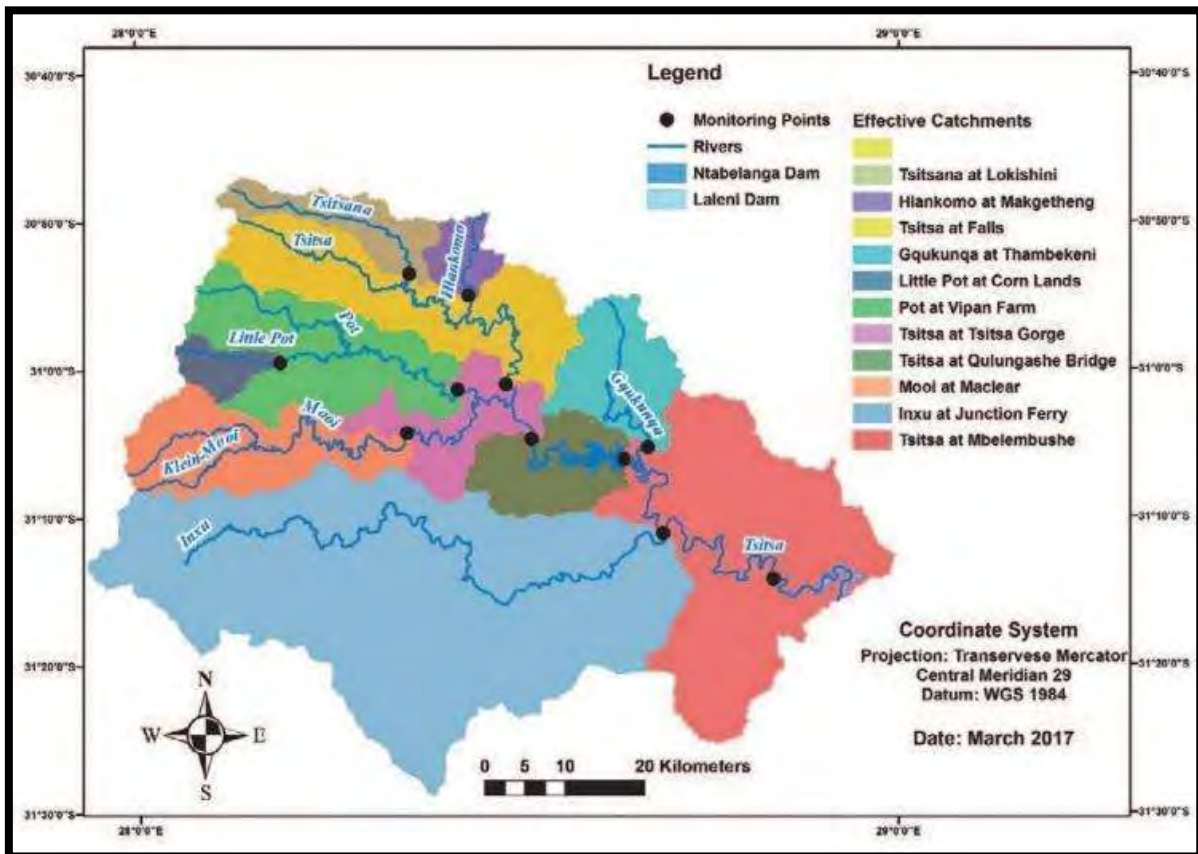


Figure 4.1: Map showing Ntabelanga catchment sampling points (Source: Nyamela, 2018)

It took up to a full day to go through the Memorandum of Agreement, safety briefing, and training material with the monitors and to undertake practical sampling training. The work initially began at the monitor's home where the background to the project and the monitor's part in this was explained, together with the role of the field technician. The monitor was familiarised with all the equipment and given an overview of the sampling procedure.

The method was not straightforward for all monitors from the beginning. For example, E7 stated that *"when she first came here she explained everything, I heard everything but did not understand what she expected from me. I understood over time"*. But for some it was easier to understand, e.g., E9 stated that *"the whole system was pretty much self-explanatory. So, once you have done it once then it's like question and answer."* Bannatyne (2018) reported that in the Tsitsa River catchment she found that the majority of monitors were able to continue independently with baseline and flood sampling after the initial training intervention.

4.4.2.6 Safety training

The personal safety of the monitors was important at all times; this included going to take a sample and returning home. Monitors were not allowed to sample at night and should never enter the water for sampling, even at very low water levels. Similarly, they were told not to attempt to sample when bank or weather conditions are dangerous (e.g., during lightning storms or when the bank is slippery or has been washed away). Monitors should always wear a lifejacket whilst sampling, for floating assistance and visibility to the surrounding households while sampling. During the training, and any time after that, they had to be able to show that they could put on and secure the lifejacket correctly. Self-rescue techniques for floating and using currents to assist with exiting the river safely were explained. Alcohol usage and the presence of children during sampling activities is prohibited. These all form part of the sampling protocol which is included on the Open Data Kit form that was created by the researcher.

4.4.2.7 Smartphone-based data collection: Open Data Kit and KoBo Toolbox

Software-enabled smartphones were used to sample. They provided communication, data reporting and compliance-checking functions that were required to support monitors during sampling. Data management in the Tsitsa was performed using Open Data Kit (Anokwa, Hartung, Brunette, Borriello, & Lerer, 2009) and the KoBo Toolbox. Open Data Kit collect forms were loaded onto smartphones to guide the monitors during their sampling, and to send the resulting data through the mobile network to the receiving database, Open Data Kit Aggregate. Administrators could download and delete saved forms during site visits, and could upload/delete blank forms as necessary.

4.4.2.8 Field administration

The field technician undertook field visits at intervals (e.g., every one or two months) in order to collect the suspended sediment samples and to download the saved forms from the smartphones as a back-up to the Open Data Kit Aggregate database. These visits provided opportunities to support the monitors, resupply with sampling equipment and other consumables and if necessary, replace damaged equipment, review sampling technique and protocols, and resolve any quality-control or performance issues that may have emerged. The field technician sent data and airtime to the monitors and checked the smart phones for any personal use. Field technicians also paid the monitors according to the number of samples they reported at the end of the month. The number is confirmed with Open Data Kit downloads.

4.4.2.9 Monitors working relationships and non-compliance

In cases of non-compliance with sampling protocols, monitors were usually 'given the benefit of the doubt' and given guidance and correction rather than losing pay; they received warnings for the first few non-compliances. The aim was to ensure that samples were taken according to protocols and that payment for this was fair. For misuse of equipment, data and airtime, a first verbal warning was given. There were a few instances where this approach was unsuccessful. Following repeated non-compliance with the same protocol and misuse or neglect of equipment, a written warning was issued. Three written warnings for the same offence lead to dismissal. The corrective process was a means to avoid the need to identify and train a replacement and avoid time wastage. Since sampling must continue at the same site, replacing a monitor could cause tensions in affected households and community areas.

Some monitors' contracts were terminated, i.e., they were 'let go', because of funding constraints and for some sites, the researcher had received sufficient data from the sampling points. Another reason for termination, especially in the Lalini catchment, was that there was no work conducted by the Tsitsa Project at time of termination.

4.4.3 Level 2 mechanisms

The Level 1 mechanisms can be seen as resulting in different outcomes, by triggering different Level 2 mechanisms among the monitors. Different aspects triggered different outcomes, like 'easy money' triggered an acceptance of the job and a decision to stay in the catchment, followed by flood focused sampling (e.g., for E10). But the same 'easy money' triggered different responses from other monitors.

This section considers what deeper (Level 2) mechanisms the first level mechanisms triggered from the monitors. First, we look at the mechanism involving a white English-speaking person (the researcher) recruiting and training monitors. What did this trigger cause? Many potential monitors simply declined further engagement, and referred the researcher somewhere else, to another homestead where there was a known 'educated' person. The majority of those who eventually became monitors mentioned that they were a bit scared the first time the researcher approached them because she was white and only spoke English; some were confident because they were not scared of white people and could speak good enough English.

When they were selected, some doubted themselves and whether they would be able to do the right thing or follow the rules. Some felt lucky, trusted and vowed to be dedicated as a result. For most, money was the main motivating factor and realising that the job did not require (E6) much and it was near to their houses (E8). The money was so appealing that even individuals set to go to big cities stayed for as long as they could (E10). One special individual took the job because the researcher begged her to and over time she became more aware of her own river (E7).

There were a few that took the job due to what I will call 'the need for stimulation'. These monitors mentioned they were curious and wanted exposure to what the project was doing. Some simply took it because it was a job, like E13 ("*I am just playing my role*"). Case 3 in Box 4.1 represents a different perspective from the mini cases presented earlier. Case 3, E1, is included as it provides a different set of insights from the two embedded cases. One could say that this case sits in the middle of the spectrum between the two extremes of the embedded cases. For example, E1 was not recruited based on her English language or technical competencies, but rather because of the location of her house and because her daughter was there at the time the researcher was looking for a monitor and was able to translate the conversation between her mother and the researcher.

Box 4.1: Case 3

Case 3 - A woman eager to earn money despite the communication and technical challenges

E1, who was the oldest monitor, got the job because of having a daughter who was educated and could speak English. The daughter was the first choice for the researcher but the daughter wanted a job in Cape Town. E1 accepted the job straight away because of money. She stated that it was difficult to grasp what was going on. She was confused at first, but was given the opportunity to ask questions, which she did and found the scientists to be patient with her. She, unlike other monitors, is doing extra things to earn money, like selling clothes, has a lot of responsibilities and does not really have someone looking after her. She has a husband who does not take care for her financially (he has a problem with remembering people) and she is his second wife. Her children are building her a house, but she still resides in the first wife's house. She has children looking out for her but money is tight and she needed the extra income. She uses the money for household necessities, for her children and for furthering her business; she was using it very wisely and was conscious of this.

The interesting part about her was that she was clearly interested in the money and she did not think that someone would do the job if there was no payment. In addition, however, she mentioned that she had learnt something about the river (noticing the change). Although the job has come to an end for her, she still enjoyed going to the river, taking random pictures, reminding herself of the time she used to sample. She misses carrying the two-litre collection water with the jam jars. She sampled until her services were no longer required (sufficient data, no further money) without ever getting a written warning.

4.4.4 Understanding interactions between the mechanisms, context and the outcomes

4.4.4.1 Introduction

Different people valued various things differently. In this section I explore the relationship between the contextual features and the different levels of interacting mechanisms and how this has led to outcomes in particular contexts.

The outcomes (benefits and unattained benefits) include, but are not limited to, social psychological and personal outcomes; material benefits outcomes (money and the things it buys); relational or status outcome; learning outcomes (not many but there is potential); and continuous monitoring/science outcomes.

Figure 4.2 implies the same relationship between C-M-O as in Figure 3.1. It is the same in that the context plays a big role in the C-M-O methodology, the mechanisms interact with the context to produce outcomes. Figure 4.2 illustrates the relationship between the context, mechanisms and outcomes in the simplest way, while figure 4.3 provides more detail. Embedded cases will be discussed in this format to illustrate the interactions between C-M-O in each case. They will be preceded by narratives that tell the story of the linkages presented in the diagrams.

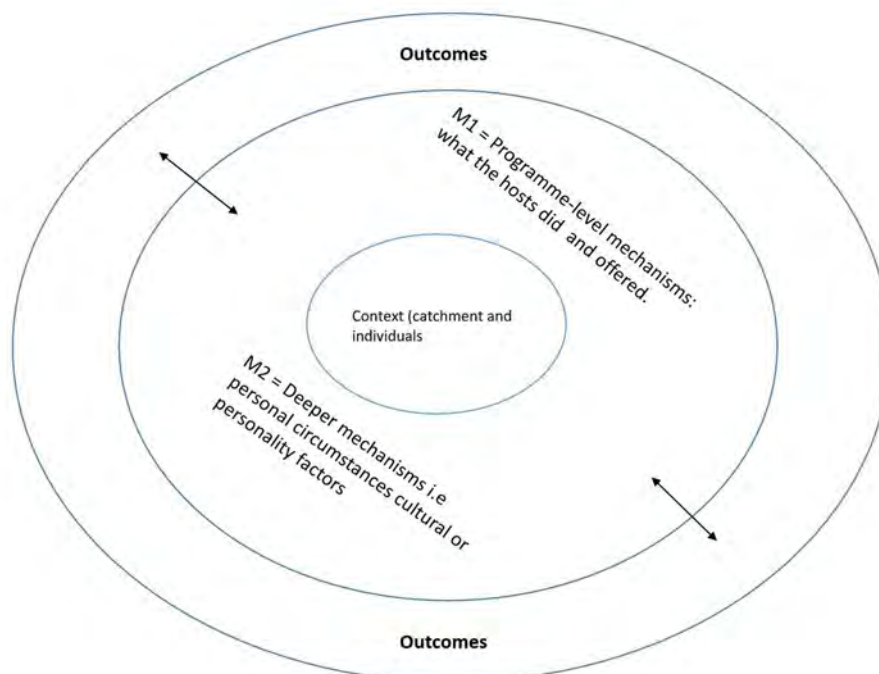


Figure 4.2: Diagram showing how the C-M-O interacted

4.4.4.2 Interactions of C-M-O in Case 1 (E10)

Figure 4.3 indicates the C-M-O interactions for E10 who had a bad relationship with his father and knew the inside of the court of law (C). This is indicative of a pattern of disregard for authority (M2) as was further evident in E10's dismissal of traditional leaders, his general rebellion against authority (including his employer in Cape Town) and his challenging of senior figures. The combination of carelessness (M2) and disregard for authority (M2) led to him being fired (O). One can assume that lenient supervision (M1) combined with a personal reckless way of behaving (M2) may have made him careless with project phones that got lost (O). He continued with the project until he was fired. If he had been treated more firmly (M1), he may have rebelled, left earlier and found something else to do. As a result of the lenient or respectful treatment (M1), he felt that he had a good relationship with the coordinators (O). As reported by the researcher in her thesis, E10 provided good flood data but was inconsistent with baseline sampling (O). He was 'flood focused' because of his personal enterprising behaviour (M2) and the programme mechanism in which monitors get paid per sample (M1) (R20x2 baseline per day, R30x20 floods samples a day).

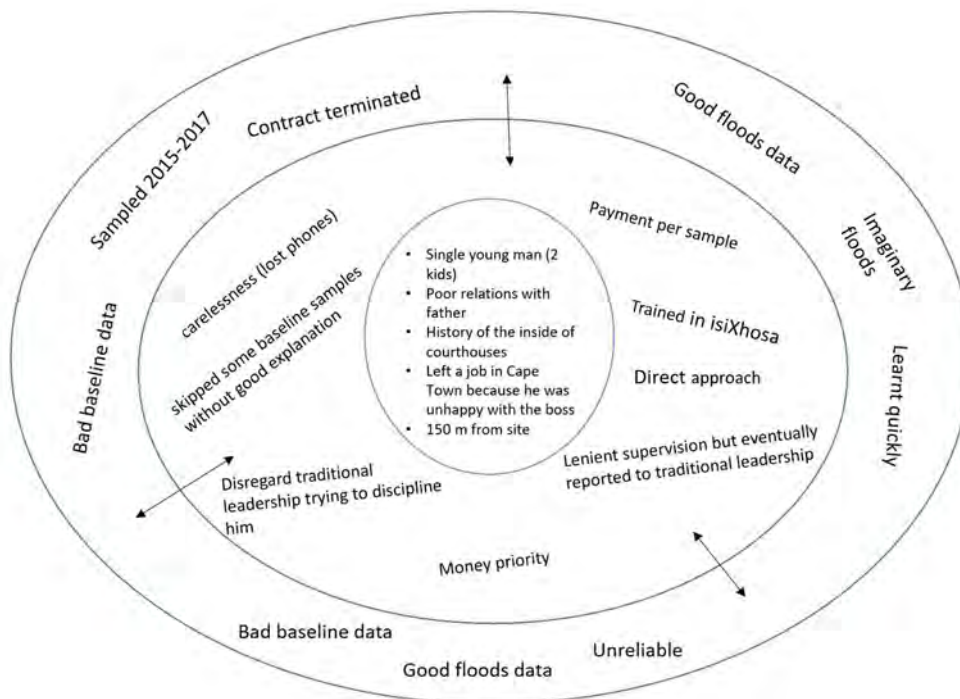


Figure 4.3: Diagram showing interacting context, mechanisms and outcomes for participant E10 (Case 1)

4.4.4.3 Interactions of C-M-O in Case 2 (E6)

As presented in figure 4.4, E6 differed from E10 in not being entirely motivated by money (C). While the money was still important to her (M2), she always did her best (M2) to sample both baselines and floods. Other important aspects for her included gaining knowledge (M2) about the environment, a growing interest (M2) in the water sampled, more awareness and a good and mutually respectful relationship with the coordinators who she felt were ‘nice people’ (M1, M2). Being trained in isiXhosa was important for her (M1). Her outcomes in terms of data quality (O) may not have been very good because she missed some samples but she remained part of the project because she tried her best and communicated when she had concerns.

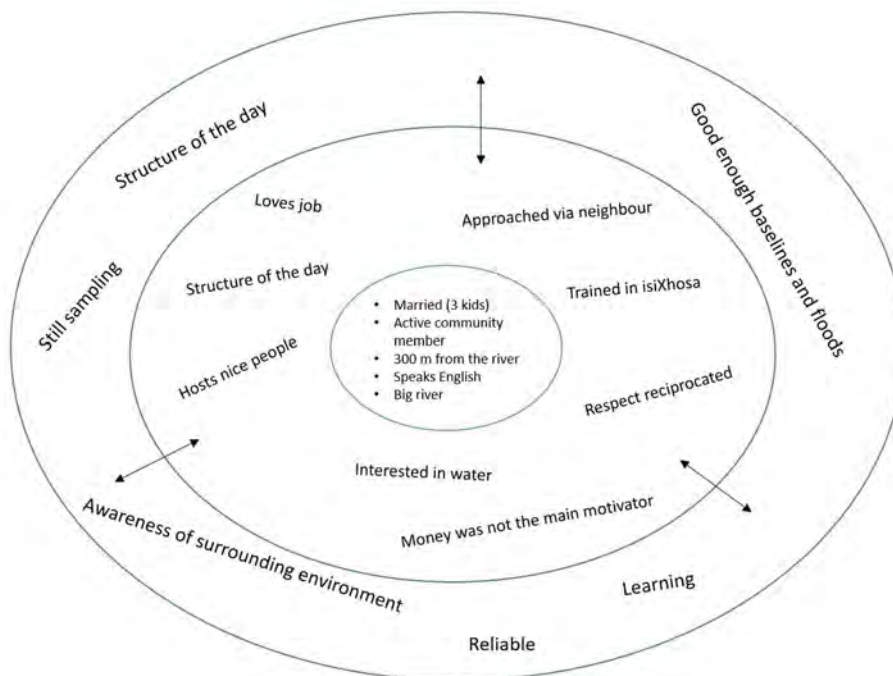


Figure 4.4: Diagram showing interacting context, mechanisms and outcomes for participant E6 (Case 2)

From the above two cases, it becomes evident that outcomes have emerged from interactions between the context (individual and catchment context) and the mechanisms (M1 and M2). For example, E10’s personal relationship with his father and with other authority figures (personal context and mechanism M2) interacted with the way in which the programme was implemented (mechanism, M1) to result in a negative outcome for E10 in the programme. In Case 2 (E6), the monitor’s stability in terms of her family situation (individual context) and her personal

commitment to doing her best and maintaining good relationships (M2) interacted with the programme's offerings (mechanism, M1) to produce positive outcomes for E6.

4.5 Enabling and Constraining Factors for the Initiative

The mechanisms that were introduced into the context, as well as certain contextual factors, can be seen as enabling and constraining factors that either enabled good monitoring outcomes, or constrained good monitoring outcomes. They include programme-level mechanisms, i.e., what the Rhodes University staff did and offered (recruitment, training, management, the nature of the job itself, payment) (Level 1 mechanisms) and deeper mechanisms, i.e., personal circumstances including deeper cultural or personality factors (Level 2 mechanisms), as well as contextual features like technical or weather-related factors, represented in Table 4.3.

Figure 4.5 shows how the monitors have to navigate between the different contextual factors that influence their ability to work productively. For example, E6 had to manage both the distance from the river (natural factors) and family responsibilities (personal factors), yet she remained a successful monitor. These operate as enabling or constraining factors for the environmental monitoring initiative programme.

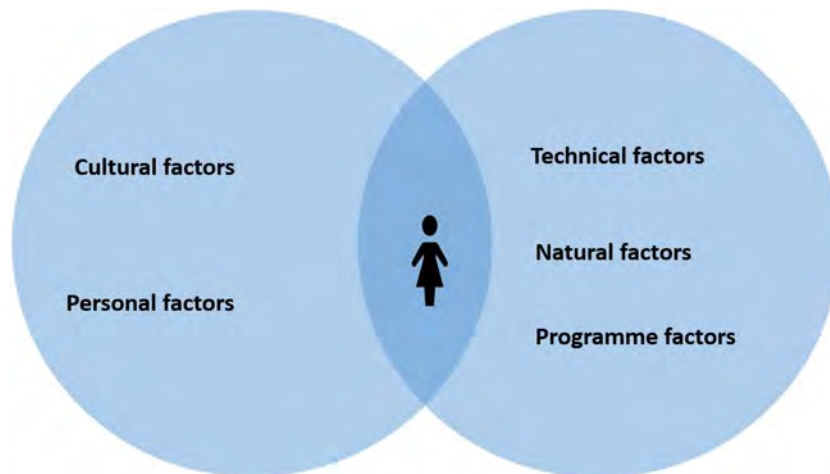


Figure 4.5: Monitors have to operate in the overlap of five factors which operate as mechanisms and therefore as enabling and constraining factors

Table 4.3: Enabling and constraining factors for monitors

Monitors			
Technical or environmental factors	Personal features	Cultural factors	Programme factors
Enablers			
<ol style="list-style-type: none"> 1. Good weather 2. Availability of electricity 3. Good cell phone reception 4. Distance from sampling point 	<ol style="list-style-type: none"> 1. Family support 2. Respect reciprocated (common courtesy) 3. Human wellness 4. Enough free time 5. Literacy 6. Agency 7. Caring person 	<ol style="list-style-type: none"> 1. Community acceptance 2. Local leadership buy-in 	<ol style="list-style-type: none"> 1. Cell phone 2. Sampling pole 3. Safety jacket 4. Safety boots 5. 2 litre bottle with weights 6. Clarity tube 7. Chlorine pills 8. Sampling jars 9. Notebooks and stationery 10. Payment 11. Language 12. Recruitment processes 13. Training processes – method, content, materials, where training happens, how often, follow up options; languages used, termination
Constraints			
<ol style="list-style-type: none"> 1. Bad weather conditions 2. Danger of sampling 3. Cell phone reception 4. Phone technical failure 5. Electricity problems 	<ol style="list-style-type: none"> 1. Family challenges 2. Extra mural activities 3. Drinking 4. No stand-in 5. Carelessness 6. Primary job 7. Social life 8. Laziness 9. Lying 10. Losing equipment or breaking it 11. Family members tampering with the equipment including the phone 	<ol style="list-style-type: none"> 1. Community commitments 2. Cultural activities like <i>umgidi</i>/initiation school 	<ol style="list-style-type: none"> 1. Running out of sampling equipment 2. Not having someone nearby to correct mistakes 3. Geographic distance 4. Lack of protocol

4.6 Summary of Findings

This chapter has represented the findings of the study following the C-M-O configurations.

Outcomes and benefits showed that the monitors valued the money, but that there were also other less tangible outcomes relating, for example, to personal growth and a sense of purpose.

They learnt very little besides the data collection and repeating technique, yet in many cases their interest in the river and in the scientific process increased. They appreciated more learning (about nature) and also saw this as a pathway to further jobs. Some of the unattained benefits that people mentioned included a wish to receive certificates and to be more involved in the process of analysing the samples. There was no further teaching from Rhodes University staff, therefore this can be considered potential that was lost.

The monitors felt cared for and appreciated in the way they were engaged, managed and trained.

Some monitors had problems with the community treating them differently; others were able to teach curious community members about sediment and the sampling techniques when they interacted with the monitors at the sites.

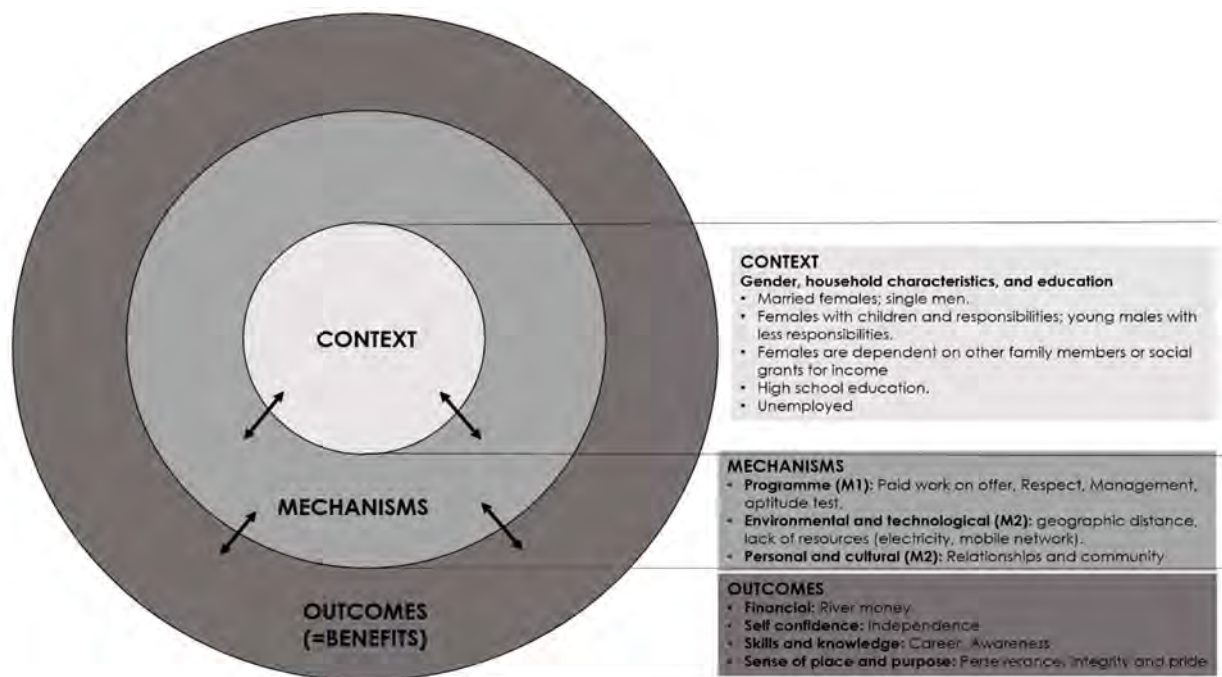


Figure 5.2: Synthesised layer of analysis of Figure 5.1

Figure 5.2 visualises the general context in terms of gender of monitors, their household characteristics and their education levels. This is followed by mechanisms that include Level 1 and 2 in relation to my study. Finally, the dark grey box is representative of the many outcomes that were reported by the monitors; this is not inclusive and Figure 5.1 represents these in detail.

This chapter will discuss the findings that were presented in Chapter 4. The line of argument of the discussion tries to answer the research questions and so it will begin by discussing the potential and actual benefits for DEA-NRM, Rhodes University and the monitors. This will followed by a discussion about why the benefits were achieved or not. The enabling and constraining effects of the programme follow and finally, some educational recommendations.

5.2 Potential and Actual Benefits Achieved for DEA-NRM and Rhodes University

The host organisation (managers) achieved their original and for them most important outcome: suspended sediment data was collected by the environmental monitors (see section 4.3.1.2). This is similar to citizen science benefits as mentioned by Reed et al. (2010) who listed measurements taken over long or very short time frames with large resultant datasets for analysis by scientists as a key benefit. Bannatyne (2018) supported this finding in her thesis stating that the project collected the spatial and temporal suspended data it required and monitors received payment

and gained work experience while close to their homes. The managers may have had some dissatisfaction with the quality of the data from some sampling points, but they gained good enough data through a cheaper method than planting probes across the catchment (see section 4.3.1). As described in the literature, data collected by citizens can both be good quality and bad, depending on attributes which differ depending on the context (Dickinson, Zuckerberg, & Bonter, 2010). Burgess et al. (2017) also supported this finding saying that project managers report inconsistent data quality across citizen science projects.

The data revealed some unexpected or unintended results, such as issues linked to building relationships with the monitors, and learning or getting to understand more about the context and the rules and norms of rural areas (see section 4.3.2.2). Furthermore, the programme managed to send money into the catchment as per DEA-NRM's main goals of trying to alleviate poverty (https://www.environment.gov.za/branches/environmental_programmes).

The managers had certain assumptions of monitors' benefits in being part of the programme. They assumed that they had gained experience but no one has studied this in any depth to identify the gaps, especially regarding learning. The most important feature of the training experience was mostly technical for the monitors. Along with the benefits, there have been some challenges for field technicians ranging from finding suitable monitors to phones being lost (see section 4.3.1.3).

Following the experience of implementing the environmental monitoring initiative for two years, the managers have recognised they need to pay more attention to how to work with people because this helps them get better data and may motivate the long-term continued involvement of the monitors. This is supported by Raddick et al. (2010) who said it is important to focus on the participants' learning about science content and process, and to develop resources to maximise learning, as opposed to the technical protocol alone.

This is part of what motivated my research. While I was a field technician in the initiative, I became interested in trying to understand what could have led to monitors who are part of the same initiative or project, having different outcomes.

5.3 Potential and Actual Benefits Achieved for Environmental Monitors

The main actual benefit for the monitors was the money that would come with the job (see section 4.3.2). This was the main reason most monitors accepted the job but there were also a few individuals that took the job because they wanted to help the researcher. Land-Zandstra et al. (2016, p. 47) stated that “some participants become involved because they want to contribute to scientific research or to the environment.” Interest to help with research is one of the reasons citizens get involved in citizen science (Hobbs & White, 2012). As discussed in section 4.3.2, monitors were paid per sample, with floods bringing more money. Some did their best to perform well. However, one individual who realised that flood focused sampling brought in more money discovered this was a way to cheat the system (E10). As a result, he missed many baseline samples. This study has confirmed what Bannatyne (2018) has found: the most responsible (in the sense of personal characteristics and family responsibilities) monitors were the most reliable when it came to sampling as they had more to lose than those who did not have or feel a sense of responsibility.

Case 3, in Box 4.1 in Chapter 4, presents one of the monitors that had another business that was assisted by the money she received from the monitoring job to help support her children. Unlike the monitors that were living at home with some form of support structure from their families, the ones responsible for their families could not afford to lose the job, possibly their only chance, at that time, to earn something while working from the comfort of their home. This difference is as a result of their varying contexts which has been described in Chapter 3 as a factor that plays a big role, in relation to mechanisms, to determine the outcomes. As Sfard (1998) stated, the context is rich and diverse on its own. Contextual factors interacted with personality and cultural factors (deeper mechanisms). The responsible ones were the females, mostly married with children and owning their homes. This is not to say that none of the young and single people who were part of the project were not reliable, as there was the special case of E13 who was. This could be because he had a vision (M2) of going back to school, and needed the money to support himself and his family. Although not described in a comparison of who was most reliable in the report by Swemmer et al. (2015), the majority of the monitors in their research were also females with dependents.

There were other benefits besides money, some of which were unexpected. Appreciation of the relationships built within the initiative, with the manager or with other monitors were amongst these benefits for some (see section 4.3.2.2). This is one of the outcomes that can be enabled by citizen science (see section 2.2.3 in Chapter 2). The reciprocated respect, and learning how to work with people, especially people of other cultural groups, were other benefits. Many monitors loved the attention from admirers in the community who sometimes called them “river people (*abantu bamanzi*)”. Some monitors, however, were subjected to jealousy from community members (see section 4.3.2.4 and Table 4.1 in Chapter 4). There were questions and concerns from the community about the small number of beneficiaries in the project. This can invoke jealousy and can put people at risk. In my study there were no findings to suggest such risk, but it is worth continuously tracking and monitoring this.

Confidence in their ability is also mentioned as a beneficial outcome, similar to the report by Swemmer et al. (2015) where monitors reported that their confidence or self-belief had grown since becoming part of the K2C. This is an important feature of findings; in her framework Phillips (2017; Phillips et al., 2018) included self-efficacy, which is the extent to which the learner has confidence in their ability to participate in science-related activities.

Although this form of benefits has to be qualified, most monitors mentioned gaining knowledge about the work they were doing as well as an awareness of their surrounding environment. This was the most common benefit of working with citizens mentioned by the literature. For example, Hobbs and White (2012) noted the importance of learning about the bigger picture, personal learning about the context they work in. This could potentially plant the seed of stewardship in participants. This is supported by Braschler (2009) who stated that when citizens are involved in monitoring, they gain an appreciation of biodiversity and the functioning of ecosystems.

The framework of Phillips et al. (2018) (see Figure 5.3) articulates an individual’s potential learning outcomes from participating in citizen science related work. Some of the outcomes exist in the Tsitsa Project environmental monitoring initiative and some do not yet exist in the project, but have the potential to develop. Note: The central pie diagram in Figure 5.3 is based on a framework developed by Phillips et al. (2018) which was adapted in this study (two additional wedges in green) and the rounded text boxes are findings from my study.

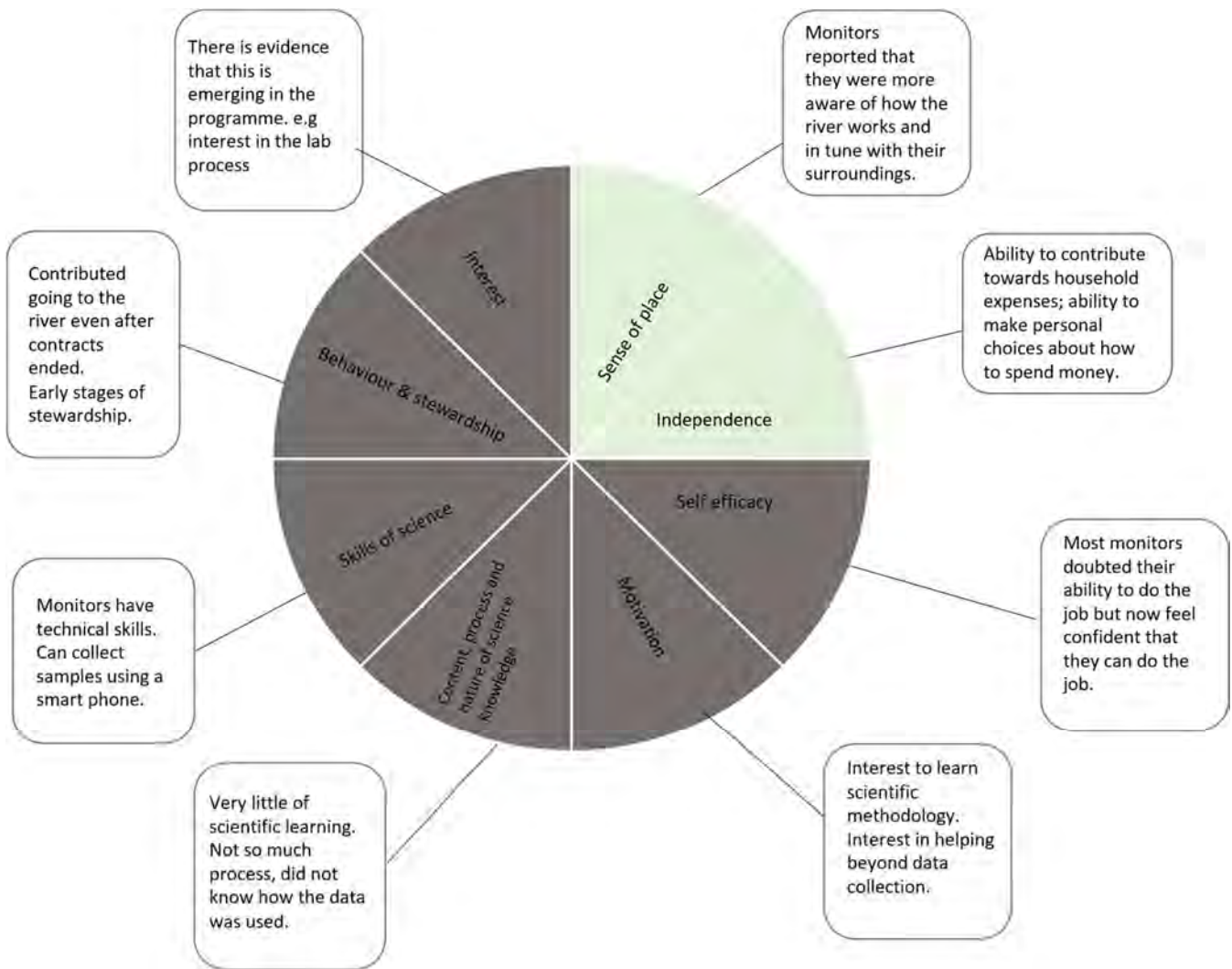


Figure 5.3: Outcomes of participating in monitoring programme adapted from Phillips et al. (2018). Two more outcomes (light green coloured wedges) were identified in this study.

My findings have shown some small changes in behaviour, e.g., people going to the river and taking pictures even when they are no longer employed by the project; this is a sign that behavioural change is possible. In my case, confidence in being able to work (equated with self-efficacy in Phillips' framework) was valuable. There is evidence from my study that interest in scientific work is growing or emerging.

Missing from the original framework by Phillips et al. (2018), which have been added, under behaviour, are things about experiencing nature, a sense of place and identity which I recognise are important ways of relating to the environment in a positive way. For example, monitors reported that they were more aware of how the river works and all the changes and influence it

has on the riverbanks. Masterson et al. (2019) reported that there was increasing literature that links well-being to nature and its benefits. Their model showed how the mechanisms by which people derive benefits from nature can potentially influence values, attitudes and action towards nature that supports well-being. In my study this was evident in the monitors who, after the job terminated, went back to the river where they experienced connection with the place, a form of human-nature connection. Reconnecting, for monitors, can help them realise how much they had stopped noticing the changes that happen around them. This (taking note of something and being interested) can be identified as early steps towards stewardship and behaviour change. Lawrence and Suddaby (2006) supported this when they stated that data collection contributes to the relationship between person and place or person and natural objects and may affect the values of citizen participants.

Because the framework developed by Philips et al. (2018) focused on voluntary citizen science programmes, it is not fully representative of my findings. A missing aspect that was important in my study was money as a motivator for good quality data and for retaining monitors, which led to some connecting more with their environment.

5.4 Why are Potential Benefits Achieved or Not Achieved?

5.4.1 Introduction

This section links to the questions presented in sections 5.2 and 5.3 above. It tries to understand how the benefits took place or why they did not.

In my view, one of the main factors that facilitated the benefits achieved by all involved, was appointing a coordinator, referred to as a field technician (the job described in detail in Chapter 4 under section 4.4.2.8). Similarly, Hulbert, Turner and Scott (2019) stated that having a coordinator to manage the citizen science programme helps relieve pressure from the researcher's workload and this helps the project be sustainable.

Most of the potential but unachieved benefits were not achieved because they were not planned. These include fostering learning, training or upskilling of the monitors beyond water sampling. The main focus for sampling was data collection and related benefits like publications (section 4.3.1.1). In a study conducted by Phillips et al. (2018), it was found that the majority of projects

that worked with citizens listed data collection as the main intended outcome with skills and learning being the least-measured outcome of these projects.

This research has identified that monitors felt more could be done for them, like awarding certificates and giving them more information about what happens to the samples of water, or even exposing them to the laboratory process that follows after the water has been collected. This potential benefit was mentioned by the monitors who joined the initiative out of curiosity and for exposure to scientific research. K2C monitors also shared these sentiments (Swemmer et al., 2015) even though they achieved much more than Tsitsa Project monitors. Similarly, Bell et al. (2008) suggested that giving participants certificates may be beneficial as this provides a feeling of pride and accomplishment and demonstrates their long-term commitment to the project which may contribute to retaining them further.

For Rhodes University, the main potential benefit that was not fully achieved was the quality of data expected. There are a few reasons for poor data outcomes from monitors and these include lack of dedication on the part of some monitors, having a more permanent job which meant they could not always be available to sample; and some did not understand how to sample at first. Bannatyne et al. (2017) identified the following reasons as having played a role in the behaviour of monitors: slacking in work, cheating, inability to count, and losing phones. Hulbert et al. (2019) also identified attitudinal barriers which included impatience, confusion with the technology and loss of interest. Similarly, Nyamela (2018) reported attributes including monitors' personalities, physical abilities and availability. In Nyamela's case (Inxu River Catchment), technicians who were responsible or able to collect samples lived in areas where they could not monitor the river level well and missed flood events, were involved with other activities, lost interest or had other work opportunities which took them away from the catchment. Family obligations also played a role. When people left it was difficult to get replacements as there weren't enough suitable people in the area. The limited number of people and unoccupied houses is as result of out-migration to find work in cities as explained in Chapter 1. This section shows that monitors' ability to perform well is heavily affected by their context and their individuality. Therefore, it is important to understand both the contextual and individual dynamics. One can never identify one single aspect that prevents monitors from performing well. My study shows important underlying features that help understand certain behaviours and attitudes which explain the outcomes of the

programme/initiative, each of which will be discussed in turn below. It would seem that a pattern is emerging that is worth investigating further.

Below I discuss the two topics that were realised as playing a big role in the benefits achieved. That will be followed by discussion of the missed opportunities that can be adapted by similar projects.

5.4.2 “Easy money”

The research team made the assumption, because of the high level of poverty in the catchment, that without the incentive of payment for services, the sampling protocols were unlikely to be adhered to, and the programme could not be expected to provide data of the required confidence level. Quality control and compliance, whilst supported by the Open Data Kit platform and smartphone technology, could not have been effectively managed in the absence of a formal agreement which included remuneration for sampling.

Money to pay the monitors to collect the data has had the most influence in getting data and motivating some to remain dedicated to the data collection process, as well as motivating them to not leave the catchment (section 1.3.2 has described the reasons for out-migration). Some monitors mentioned they would not have collected water samples for free nor been as dedicated (see section 4.3.2.2). The carefully thought out per-sampling payment system contributed significantly towards the successes and motivation. Hulbert et al. (2019) supported this finding, saying that a financial incentive approach in citizen related data collection is important for enhancing the impact. One potential monitor who was being trained, needed the money but did not perform well, which shows that money is not the only or overriding factor for success.

This section suggests that each individual has internal mechanisms that influence how the individual responds to the mechanisms introduced by the programmes. Monitors respond differently to the same mechanisms of an initiative.

5.4.3 Building and maintaining relationships

A second important aspect is the interpersonal relations and the trust that has been built over time (see sections 4.3.2.2 and 4.4.4.1). This is important when trying to retain good working relations. Good communication between the field technician and the monitors also proved important. Another relationship that had an effect is the one between monitors and their

families. When families were supportive the monitor was motivated by more than the money alone. Table 4.3 in section 4.5 highlights family support as an enabler.

The longer the involvement in research related activities, the better the chances of monitors staying longer or being interested in similar related activities (Lawrence & Suddaby, 2006). With increased interest, all benefits might improve, i.e., monitors may become better at the job and even more interested, more knowledgeable and more inclined to stewardship. While the primary goal may be a scientific one, engagement in citizen science could lead to skills in forming and maintaining partnerships (Bela et al., 2016).

5.4.4 Missed opportunities

One missing dimension that emerged was listening to the monitors or learning from them. I consider this a missed opportunity to share and a chance to improve the data collection by the monitors; this could also be empowering and lead to monitors feeling more included as part of the research team. The project also missed out on understanding mechanisms that were triggered by the programmatic mechanisms introduced into their space and teaching monitors something new. As results have shown, the programme affected people in various ways and expected them to all yield the same outcomes because they had been trained and treated in similar ways by the programme. As result of the failure to listen to and learn from the monitors, the programme was unable to understand 'deeply' the different contexts and how this could affect the monitors' outcomes. Another missed opportunity was that of ongoing training and more frequent contact with monitors. This has been reported to play a role in retaining monitors in programmes and could spark more interest in scientific methods, which could lead to further job or study opportunities for individuals with potential.

Because of how the project started (see Chapter 1) and the lack of opportunity for monitors to share their learning, no one was aware of their interest in what happens to the water after it was taken from them. This was a big 'missed opportunity', especially for the more curious or interested monitors. More value and motivation may have encouraged monitors to stay longer and a more in-depth scientific understanding of the programme may have led to them wanting to study science further. Research suggests that the more intrinsically motivated people are, the more effort and persistence they will have for a particular activity (Ryan & Deci, 2000). Phillips (2017) revealed that participants who are adequately motivated experience satisfaction with the

activity linked to this, which is likely to lead to more participation in the future. Equipping monitors with more knowledge as well as sharing results with them helps validate the work they do as good and gives them a sense that they are worthy (Hulbert et al., 2019). The Tsitsa monitoring initiative expected that treating everyone the same way, in terms of management and recruitment, would give the same consistent and reliable results (good quality data) but we were surprised by how responses varied. This study showed why that might be the case by looking at the context and mechanisms of each monitor involved. The study also found that not everyone was treated in exactly the same way (see section 1.2.3.1.1).

5.5 What are the Enabling and Constraining Factors within the Programme?

5.5.1 Introduction

This section discusses the factors that are presented in Chapter 4 in Table 4.3 and tries to answer question four but in doing so it also includes questions one to three. I will discuss, in relation to my results, what has contributed to the success and what has hindered greater success. As mentioned in the previous section, money, relationships, trust and sampling equipment play a big role. But also important is maintaining relationships and communication, and facilitating support from local leaders. The field technician plays an important role of regularly checking up on monitors, and being willing to help when needed.

Phillips (2017) listed similar constraining and enabling factors. These include weather, health or age-related issues, technical requirements, travel distance, access to sites or liability issues, commitment requirements, lack of confidence, harassment from other people, loss of interest, etc. (see Figure 4.5 and Table 4.3). These are mechanisms as described in Chapter 4 (section 4.5). Most of the mechanisms mentioned by Phillips (2017) are discussed below as factors which have constrained or enabled the Tsitsa programme. The factors presented are programmatic, technological, contextual and finally, personal and cultural factors.

5.5.2 Programme factors (Level 1 mechanisms)

These are the factors that come with the project and are dependent on it in that they are introduced by the project. As described above and in Chapter 4, Level 1 triggers Level 2 individual and underlying mechanisms.

5.5.2.1 Lack of protocol

Constraint – As mentioned, protocols developed over time with the project. One of the strategies we thought was useful was having local leaders select potential monitors, but mostly they pinpointed a single individual as the only candidate. This generally had negative outcomes although some good monitors were selected through this process. Local rules and norms were not well understood by the researcher. There were no formal interviews or screening, therefore the field technician, who did understand the local context, did not have a chance to learn the potential challenges related to individual candidates.

Enabler – In some areas the lack of protocol helped as certain monitors were chosen without the input of local leaders and remained active in the programme. Lack of protocol in this instance enabled the initiative to get good enough monitors that have remained part of the initiative.

5.5.2.2 Training

Constraint – The only constraint that emerged strongly was how some monitors felt confused initially about sampling floods. This was explained in more detail during the final feedback of my research (member checking) session. Some did not understand what “sample the first 10 samples every 45 minutes” meant; for example, E6 indicated that she had to ask a local nurse to explain how that works. E6 knew that nurses often work with intervals.

Enabler – The training was considered sufficient by the managers and most monitors. Bannatyne (2018) reported that most monitors managed to sample independently after the first training, but there were some monitors that found it difficult to understand the process. Crall et al. (2011) reported that participants who were trained on how to use equipment for one day had high levels of outcomes, in terms of data quality. Although money is good as an incentive to collect good quality data, training remains important to ensure things are done well (Hulbert et al., 2019).

5.5.2.3 Technical

Constraints – During the feedback session, monitors noted challenges related to the equipment. For example, sometimes a few attempts are required to collect water with the two-litre container for the clarity tube. During the dry season it is not easy to throw the two-litre into the river without disturbing the settled sediment. This affects the speed at which one can take a sample.

Enabler – Phones allow the monitors to communicate with the field technician when they experienced challenges. The main use for the cell phones was data collection, quality control and sending data to the database for the researcher and field technician to access it from Rhodes University.

5.5.2.4 Engaging

Engaging is similar to relationships but I use it here to mean the way in which the field technician worked with the monitors, i.e., how she engaged them in the programme/initiative. I use the term 'relationship' for the way monitors related to the field technician, i.e., they develop a relationship with her through the programme activities. There are no constraints discussed in this section because I could not identify any to date.

Enabler – As argued in section 4.3.2.2, the manner in which one engages with people is important: being respectful has emerged as an important enabling factor. Making people recognise that the role they play in the project boosts their confidence and may motivate them to work and communicate better. The way in which we treat people can mean that even the ones who doubted themselves at the beginning ended up doing well as a result of patience and support. Dickinson et al. (2012) stated that motivating people to contribute to citizen science projects requires effort and effective communication.

It is also worth mentioning that when working with monitors one needs to understand their particular context and be able to speak their language, i.e., to get an understanding of how people expect to be engaged and the rules by which their communities operate. In this context, it was very important for researchers and field technicians to be patient with monitors at the beginning when correcting mistakes.

5.5.3 Technological factors (Level 2 mechanisms)

This section presents the underlying factors that are presented by the use of technological devices. There was only one that was identified and that is "lack of resources".

Constraints – The first and the most important resource is electricity. The absence of electricity can be a big challenge because monitors could not work when the phone battery was flat. The monitor has to have the means to charge the cell phone, usually at a nearby village or at a house that has an alternative power source (solar power, generator, etc.) and may have to pay for this.

It is also a challenge for the field technician to differentiate if the monitor's work was affected by the phone battery or other personal reasons.

The second constraint relates to technical problems. Problems with phones can affect the productivity of the monitors as they sometimes had to wait for the field technician to resolve a problem. At times it was the cell phone reception which inhibited the monitors from being able to send samples to the database. Another issue was GPS which was important for geolocation; if it did not work, then monitors could not take samples.

Enabler – Smart phones that allow the functions are needed to carry out the sampling. Also they are the means of communicating with the field technician who was based at Rhodes University (as section 5.5.3.1 will describe). Monitors that had access to electricity found it easy to charge their batteries and could collect samples continuously unless the electricity supply was affected by severe weather conditions.

5.5.4 Contextual factors

Geographic distance is the only contextual factor identified. There are two types of distances involved in context, that of Rhodes University from the catchment (monitors) and that of the monitors from the river (sampling sites).

Constraints – Being far from the sampling point is a problem in areas that are not safe for individuals to be on their own; this was especially an issue for female monitors. When houses were far away from the sampling point, no one could see the monitors. The distance also affected the monitor's ability to monitor the rise of the river as reported by Nyamela (2018). Some monitors were reluctant to travel a long distance to the sampling point. Weather conditions can also prevent sampling – lightning, heavy rains, or the sampling spot getting washed away during because of floods. All these conditions have a negative effect.

The long distance between Rhodes University and the catchment affected the ability of being able to readily assist monitors with anything. Some monitors did not report problems or challenges for fear of being viewed as stupid and would rather leave the problem until the field technician visited again (refer to section 4.4.2.2). The phone played a big role in maintaining the relationship between the field technician and the monitors. Although all monitors have access to a field

technician, some had better relations with the field technician which could be a sign of confidence. As discussed by Swemmer et al., (2015) confidence is one of the benefits of participating in the monitoring programmes. The problem of distance becomes more of a problem for those without a good relationship with the field technician or who lack confidence (see section 4.4.2 for more detail). Distance makes it more difficult to build good relationships when it is already difficult to build these connections in close proximity. This demonstrates the interactive nature of mechanisms, as also described by Pawson (2013).

Enablers – Being close to the river allowed the monitors to notice the rise and the fall of the river more easily and they were less likely to be “lazy” (term used by monitors themselves when they did not have to walk a long distance to collect samples). They are also visible to other community members making them safer. E10 was the least reliable monitor but had good flood samples because he was close to the river (see section 5.5), whereas E1, one of the reliable monitors, did not have good flood data which could be because she was far from the river therefore, did not always notice when the river was rising.

5.5.5 Personal and cultural features

These are the factors that look into the individual factors that can enable or constrain the programme. The factors discussed are personal and language.

5.5.5.1 Personal

This section discusses the effect of personal circumstances and personality factors (Level 2 mechanisms).

Personal circumstances are factors that are associated with individuals and their families. These include a person’s home context which may be affected by finances, education, and relationships with family members and with the community, confidence, ability to perform tasks, etc. An important factor that also affected the monitors in this case is history (apartheid and homelands) as discussed in section 1.3.2.

Personality factors are characteristics of an individual’s way of thinking, feeling, and behaviour. Personality embraces prevailing moods, attitudes and opinions. It includes behavioural characteristics that distinguish one person from another and that can be observed in people’s relations to the environment and to the social group.

Constraints – Personal constraints involve people prioritising other activities over working on sampling. These activities range from personal enjoyment to people having a second job to family members that damage equipment. A gap often exists between the intention and behaviour. People may intend to participate but there can be barriers to the behavioural expression of the intention (Hulbert et al., 2019). For example, family- or community-related activities may prevent intended work from happening. Hulbert et al. (2019) described how personal factors may affect a monitor's intention.

Stand-ins are meant to help when monitors are unable to collect samples for various reasons but they are not always trustworthy and the extra work for the monitor of having to manage the stand-in (payment, quality control, equipment) means that some monitors do not trust anyone else with the sampling.

Community and family obligations and events affected monitors' performance, interacting with personality factors. Traditional ceremonies often meant 'bad sampling' as some monitors cook for initiates, or take care of people, while others participate in 'welcome back parties' which usually involve alcohol and meant no samples for a few days. E10 did not have many responsibilities affecting his ability to work, but his personality was such that he prioritised social events over sampling. E6, on the other hand, was a married woman with family and many community obligations (helping in all activities taking place in the community, e.g., funerals, traditional ceremonies, etc.) yet she managed to fulfil her sampling duties. This too shows the interaction between contextual factors and the underlying mechanisms within the person and how they understood or approached responsibilities.

Enablers – Individuals that have families to look after or that need the money are motivated to make sure they do a good job. In this study the most responsible and reliable were monitors with their own families or those who had dreams of doing something with the money earned (such as further studies or an own business). According to Bannatyne et al. (2017), enabling factors include the monitors' motivation, compliance, and commitment to undertaking the required tasks, as well as their physical ability and intellectual ability. Smylie et al. (2016) also included the fitness, age and gender of the monitor as enablers. This was evident in this study as young people close to the river had an advantage over the elderly women far from the river (see section 4.2.1). This was also supported by Bannatyne's (2018) findings as described in section 5.5.1.3.

5.5.5.2 Language

As outlined in the context (Chapter 1), the majority of the monitors were black isiXhosa-speaking people; the project team was mostly white and some could only speak English. This created a language dynamic, which is described below.

Constraint – Sharing a common language promotes learning and usually has better outcomes for working together (Bela et al., 2016). The initial stages of the selection of monitors only involved an English speaker, the researcher, who intimidated or scared some people who could otherwise have been good monitors. Some people were too intimidated to participate (e.g., E10's friend) while some (like E6) were only a little nervous but managed. English was a barrier for many, who sent the researcher away when she was trying to recruit them. Having a translator for the training was good because everyone could understand many felt confident enough to ask questions.

Another factor that was a barrier for some was that the researcher was a white person, regarded by many, because of historical reasons (i.e., underlying mechanisms) as more important and powerful with more knowledge and the power to decide. The deeper mechanism (see section 1.3.3) in this instance is the historical divide and the mental state of some community members (having some level of belief that white people have more status or power).

Enabler – Working with a translator that spoke the local language (isiXhosa) and who is familiar with rural Eastern Cape / isiXhosa customs and norms helped the monitors to relax and engage better. This showed that the researcher understood or was mindful that she lacked the communication ability that was key for engaging further with the monitors. With a translator, participants felt they could express themselves and understand what the researcher was saying more clearly. Another form of the deeper mechanisms of cultural familiarity and sensitivity is expressed here. Graham and Taylor (2018) found that having a facilitator that is fluent in the relevant language was an enabler. The same applies with translating the materials produced into the local language.

A further enabling factor was having a field technician who spoke the local language because this assists in relationship formation as people are likely to feel comfortable and able to relate to such a person. It also contributes to the data quality because less information is lost in translation when the conversation takes place in the local language.

5.6 Educational Recommendations for Environmental Monitoring in NRMPs

Based on all the study findings, what are the educational recommendations for environmental monitoring in NRMPs? This section tries to answer this research question by using the findings as learnings that can be used by other programmes.

5.6.1 Long-term involvement of monitors and inclusion in 'bigger picture' of the process

As a result of increased interest in the programme, all other benefits might improve. Therefore, it is important to broaden the engagement with monitors from technical training to broader capacity development and learning. According to the international literature, in most citizen science programmes, participants gain technical skills and there is less emphasis on broader learning (Abrahams et al., 2019). This is a problem worldwide and it is evident that there is lost potential and we (the monitors and me) think that more can be done. This project could begin by providing opportunities to the interested monitors by sharing knowledge and exposing them to the restoration science behind the sampling. As Edwards et al. (2018, p. 34) stated:

“knowledgeable and engaged citizenry will support efforts to restore damaged ecosystems and citizen-based approach restoration monitoring could meet both the societal goals and data needs of restoration science”.

As part of encouraging monitors to participate in the Tsitsa Project for prolonged periods, it is important to develop a form of certification that monitors can use to apply for other jobs (see section 4.3.2.4). This could significantly increase individuals' motivation and commitment. A certificate of attendance is a tangible outcome and provides something visible to show an achievement, giving a sense of pride.

5.6.2 Recruit and train in local language

My findings have shown that people, especially in a rural setup such as the Tsitsa catchment, respond differently when they engage with an English speaker compared to an isiXhosa speaker. Therefore, I would recommend that local language be used from as early as recruitment through to training and management.

When an English speaker is responsible for training or engaging with isiXhosa speakers, there is room for confusion, not only because people are hearing things in a second language but also because translations can be confusing if the translator does not understand the science well. Even

an isiXhosa speaking researcher might have different assumptions about what people will be able to follow and how to explain things. This is due to multiple cultures coming together, including rural, science and university cultures.

With regard to stand-in challenges, it might be important to hire and train people in pairs when daily monitoring is needed. This way the responsibility of the monitor to find a reliable stand-in is avoided. This is dependent on funding but would assist when personal circumstances that are not preventable affect monitoring, and given the fact that people, even when unemployed, do have responsibilities.

5.6.3 Respectful management of human relations

As shown by E1, patience is a key factor because people are different and learn in different ways. Some are quick to learn while others take much longer. Many monitors also mentioned respect. Field technicians must always show respect; this involves getting to know monitors as people, and providing them with motivation for wanting to learn. It is important therefore to create a safe and comfortable space between the field technician and the monitors. Part of patience involves allowing mistakes and helping the monitors to learn from them.

5.6.4 Provide opportunities for socialising beyond work

Monitors must be able to laugh about mistakes and feel safe to talk about them. During my feedback session (as described in Chapter 3) monitors enjoyed being together and sharing their experiences for the first time with other monitors. Geographic distance is one of the reasons that some did not engage with each other. Therefore, events that gather the monitors are important to help them feel part of a community and process. This can also enable more social learning in a network of monitors.

Monitors should feel like they are part of the bigger Tsitsa Project. Monitors mentioned in the interviews a sense of pride, self-esteem and purpose that came with being part of the bigger project. Ex-monitors commented on missing this when they were no longer monitoring, thus this can be considered an enabling factor that should be fostered. It is important to recognise people for what they are doing, bring them together from time to time, encourage them to attend meetings, etc.

5.6.5 Monitor and evaluate learning in an ongoing way

Both my findings and supporting literature (e.g., Hulbert, Turner and Scott, 2019) suggest that considerable learning is taking place in projects involving citizens but this is seldom tested. Indeed, in this study this learning was not tested. But I have seen in my findings, and by asking questions, that some monitors learnt a significant amount while others learnt very little. Some clearly developed misconceptions about what was happening. Therefore, it is important to monitor and evaluate ongoing learning.

5.6.6 Protocol

My findings show that having a clear protocol early on in the project can help with avoiding certain challenges such as selecting people for the initiative without an option to screen the candidate. The protocol will depend on the context's rules and norms as each area is different. When going into someone's space, one should be willing to learn, be flexible and open minded. One must be willing to learn from the participants and be flexible to adjust the protocol if it does not fit the context.

5.7 Conclusion

This chapter has discussed the findings that were presented in Chapter 4 in further detail, and in light of the literature. The chapter is structured around the research questions in an attempt to respond to them using the data. Therefore, the chapter went into detail about potential and actual benefits and why they were achieved or not achieved. It then continued to consider constraining and enabling factors that can assist with or hinder the success of a programme. It finishes with the most important question, the recommendations for other NRMPs. These are lessons from other questions and literature, which are synthesised into the final chapter.

CHAPTER 6: Synthesis

6.1 Introduction

In this chapter I discuss insights and recommendations for funders, researchers, and managers of environmental monitoring (citizen science) projects, including the Tsitsa Project. I begin with a summary of the core findings of my study which leads to a discussion about limitations and a review on the methodology used. Thereafter I provide recommendations.

6.2 Context Matters

Context is an important factor to understand in order to find ways to engage with monitors successfully; this will benefit both monitors and the programme manager. The exact role of context cannot be generalised but it is key no matter how different it is.

As described in the previous chapters, there are two types of contexts: the broader monitoring initiative (Tsitsa Project) and the context of the individual monitor. It is key to remember that people are embedded in different types of contexts and therefore cannot be ‘bundled’ or treated the same. The individual monitor’s context includes their home, family, community and physical situation (personal circumstances). Personal circumstances will not always be understood by an outsider to the monitors’ context. One either has to experience these over time or monitors need to reveal them.

The recommendation to project managers, in particular the coordinator, is to pay attention to contextual dynamics, have regular contact with monitors and support them where possible. Another recommendation for project managers is to understand the local rules and norms of the area in which they operate.

6.3 Language Matters

Language has been described as an important feature throughout this thesis (see Chapter 1, further explained in Chapters 4 and 5). The monitors reported that language played a big role in who was recruited at the early stages of the initiative. It is important to understand the language of the area, as it is part of the context and should not hinder people’s opportunity to take part in the project. English is a language far removed from this context of interest and English language abilities should not jeopardise opportunities to participate as monitors.

It is also important not to enforce one's context into someone else's area. My study has shown that language is very important right from the point of recruitment through to training. Language assists in the formation of the relationships and in creating the environment that allows their formation. Not all the monitors can express themselves in English comfortably. They feel more comfortable when they can express themselves in their home language. This way they feel relaxed, listened to and can, with the help of a translator, express themselves to an English speaker. Translators play an important role in this context but it is critical to know that not everyone who speaks the local language knows how to translate; translation is a particular skill. If translation is not done properly, much information can be lost or misrepresented. There is also a need for the translator to have substantive knowledge of the topic that is being translated. Therefore, I highly recommend that monitoring programmes consider capacitating monitors with translation skills and always consider having someone who speaks the local language as part of the team.

It is important to note that in another context, language might not be an issue but in this context, given the particular history as presented in Chapter 1, language is more than simply a technical matter; it is also a way of showing respect and commitment to inclusivity.

6.4 Respect Matters

Respect can be defined as treating others with consideration, or refraining from offending (which can be inadvertent through lack of knowledge). Shared respect between the monitors and the field technician or other liaison person is essential.

Respect may not be such an important factor in other projects but in this context it was key to understand or find ways of showing respect. For example, in the context of this study, using the local language rather than English is one aspect of showing respect. I recommend that the project coordinator makes an effort to engage with people in their own language. I have not found literature on respect. It is therefore a topic worth researching further.

Part of showing respect is appreciating and recognising the role monitors play in the project. This can have a twofold benefit as it boosts the monitors' confidence and may motivate them to work and communicate better, thus contributing to retaining monitors for longer periods.

6.5 Driving Forces behind the Success of the Initiative

People have multiple forces that motivate them. While money is important, it is not the only or even the overriding reason for monitors to stay in the programme. There are multiple other motivations and sometimes they can be surprising as described in section 5.4 in Chapter 5. The individual context plays a role in motivating people. My findings indicated that married women or single women with children were motivated to keep the monitoring job as it assisted with extra income for themselves and their households. For younger monitors, the income meant independence and a sense of pride in being able to contribute to their households' livelihood.

As mentioned in Chapter 5, the longer the involvement of monitors in research related monitoring activities, the better the chances of improving the monitors' interest in more activities related to research. One of the important ways to motivate monitors is to provide a wide set of skills through training that can be of benefit to people in other job opportunities beyond the project.

Finally, it is important to explore 'drop outs' (including the ones that leave the project and the ones that are let go for various reasons) to be able to understand what happened, to gather knowledge that can be used to improve and maintain the project in the long run.

As mentioned in Chapter 5, the coordinating and managing team, together with the funding to support the sustainability of the initiative, are major drivers behind the success of any programme. This is supported by literature and is evident in this study in the findings regarding the importance of the relationships and ways of engaging with monitors.

Despite long distances and other constraints mentioned above, effective networking and relationships were established and this led to the establishment of an important base for the success of the project.

6.6 Benefits (including Learning)

The initiative underestimated the benefits that could be achieved through working with this rural community in collecting scientific data. Learning is one of the benefits that was overlooked, because it was not part of the initial plan as mentioned in the staff interviews (see section 4.3.1.1). The initiative began as a means of collecting scientific data. As stated in Chapter 1, the Tsitsa Project is funded by DEA-NRM, thus it was important to send money into the catchment

because the funding is connected to EPWP whose main goal is poverty alleviation and uplifting households through job creation, skills development (see section 1.4.3). Therefore, it was important to work with people and remunerate to incentivise their motivation. Participants reported some knowledge gained as a result of being part of the initiative. Although my study did not focus on learning in depth, it is clear that learning opportunities (as actual and potential benefits) need to be understood for this and other similar programmes.

It would have been beneficial for the monitors, especially the young monitors, to understand and learn about the science behind the analysis. For example, the initiative could find ways to practically engage the monitors in how sediment transportation takes place, the lab analysis and how to interpret the results and their significance.

It is worth investing more in a monitoring project to achieve more benefits (including learning beyond the technical skills), as more benefits are possible sometimes than those for which we plan. Benefits that may not be tangible include personal growth, behavioural change and confidence.

6.7 Learning and Training

As discussed, it is important to be aware that most monitors were initially confused and made many mistakes. Some reported that they thought they understood the process from the training but only realised that they did not when they had to sample alone. This was partly due to language misunderstandings; training is better in the local language, with the training material handed out to monitors also translated into the local language. Interpersonal relations matter, therefore the field technician or trainer should be someone monitors can communicate with and relate to. Regular check-ups, especially after the first training, are important. As discussed in Chapter 5 (see section 5.5.1.3), not everyone is confident enough to report their shortfalls and mistakes. Overall, this amounts to ongoing training being important for monitors and it is important too to monitor the outcomes of the training.

It is essential that the field technician knows how to work with people, pays attention to the relations and processes, and really invests in building the capacity of the monitors because there is much underestimated potential, as this study has shown.

6.8 Strengths and Limitations of C-M-O and General Methodology Used

Having been a field technician for a year before this research helped me understand how a field technician engages with monitors. Having had that opportunity to engage with monitors helped me understand the context better. I was part of the team that introduced the Level 1 mechanisms and I could observe how the different monitors responded. The interviews that I conducted with the monitors were a useful method of collecting data. In addition, my field notes from my time as a field technician were helpful.

Looking at the interactions between the context and the mechanisms helped me explain how monitors presented different outcomes. I might have not discovered all the underlying mechanisms but I did manage to uncover some that have been discussed in Chapter 5. The challenge I had was not trying to differentiate between mechanisms and context but identifying the different levels of mechanism. This is a recognised problem with the realist approach methodology (Dalkin et al., 2015). It is because something in the context acts as a mechanism. There were potential disadvantages to being an insider to the bigger Tsitsa Project and initiative in that my insights may not have been new or fresh. However, I did gain some new insight from the interview process and analysis.

I could have undertaken a bigger survey, sent out questionnaires or asked participants to administer questionnaires, but I think this may have resulted in generalisations that would focus on the positive aspects or those in the 'middle range'. Despite working with a relatively small population, patterns were evident because similar outcomes started to emerge from the interviews. Because it was a small population, I could use an in-depth approach; the interviews enabled me to establish rapport and people were able to share some negative aspects honestly with me. This was valuable and may not have emerged from a different type of study. Looking for the underlying mechanisms helped me to probe more deeply.

6.9 Recommendations

This section discusses the recommendations for programmes already running, for NRMPs and for researchers. These recommendations have emerged from what I learnt from this study.

6.9.1 For people who run monitoring projects (including the Tsitsa Project)

Chapter 5 described the recommendations that have emerged from this study. As described above, these include language used when engaging with monitors, reciprocal respect (see section 5.5.1.4 and 6.4) and human relations that are well managed. It is important to keep the monitors interested and involved in data collection for long periods. An important consideration for future research is to determine existing knowledge from the monitors about the subject in question. From here it is important to build the monitors' capacity beyond their immediate monitoring activities. It is also advised to include monitors in the bigger picture of the project.

Trainers need to be patient and engage with monitors in different ways during training as people do not learn at the same pace or in the same way.

One of the major recommendations is that of monitoring learning of monitors and the managers/coordinators and trying to actively support this learning from the early stages of projects (this must be anticipated in the project design). The protocol of the project forms the foundation and opens a path for engagement to take place. It is important to always try follow project protocols but also to be flexible when needed, depending on the context. Lastly, socialisation between the project staff and the monitors is key as this allows knowledge exchange and experiences to be shared between monitors and staff and also between the monitors themselves.

6.9.2 For funders of environmental monitoring projects (DEA-NRM)

It is important for NRMPs to build skills for sustainable livelihoods beyond NRMPs and to encourage agency of those involved in their programmes. Upskilling is an integral part of monitoring programmes. The more people are equipped with knowledge and skills, the more chances they have at bettering their livelihoods. Thus, all projects need to be seen as opportunities for supporting learning and skills development. From the Tsitsa Project and related experiences, it is clear there is room for improvement in upskilling.

6.9.3 For other researchers

It is important for researchers to be aware of how they are introducing themselves into other people's contexts. The more researchers understand the context, the better the working relationship between them and the monitors. Secondly, they need to recognise monitors as

people with their own lives and not simply as instruments for data collection. As mentioned above, the data analysis outcomes could be shared with monitors, as a way to both communicate respect, and to encourage learning and investment in the project as a whole.

6.10 Conclusion

This research set out to understand how best to work with monitors and how to optimise the benefits for all parties involved in the Tsitsa Project, with an emphasis on learning as a benefit of participation in citizen-based monitoring. The study found that monitors benefited more than what was initially anticipated. Though money was a potential and actual benefit, the study also found unexpected benefits such as personal growth and a sense of purpose. The project staff also benefited more than expected; they learned a considerable amount about working with people. In future it would be important to look into how much learning the monitors gained and how this can be harnessed and enhanced.

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Appendices

Appendix 1: Interview schedule for monitors

Appendix 2: Interview schedule for Rhodes and DEA staff

Appendix 3: Aptitude test

Appendix 4: Consent form

APPENDIX 1: Interview schedule for environmental monitors (conducted in isiXhosa)

Schedule No.	
Names & Surname	
Name of the village	
Site name	
Date of the interview	

SECTION B: Introduction

Help them remember me

Explain ethics that guide the research

Explain the purpose of the interview

Ask for their consent

Ask permission to record

Ask what they refer to the Tsitsa Project as [then use their term in the rest of the interview]

SECTION C: The beginning

How were you approached about the job?

Kweziwa njani kuwe malunga nalomsebenzi?

Who approached you?

Ngubani oweza kuwe?

How did you get involved?

Wangena kanjani?

Were there other candidates tested with you?

Wakhethwa phakathi kwabanye?

Did you get any training?

Wawufundisiwe indlela yokuwenza lomsebenzi?

What made you agree to take to be part of the project?

Yintoni eyakwenza uvume ukuba yinxalenye yalomsebenzi?

SECTION D: Benefits

Since you started working with the project what has changed in your life?

Lukhona utshintsho olukhoyo ebomini bakho oko waqalisa ukusebenza?

At home? In the community?

Ekhayeni? Ekuhlaleni?

What were you expecting to benefit at the beginning of the project?

Wawulidele ukuzuza ntoni ukuqala kwakho ukusebenza?

Now that you know it, what would you say are the benefits of being a monitor of the environment?

Njengoba sele uwazi umsebenzi ungathi umntu oyi-EM uzuza ntoni?

What are the benefits for Rhodes University?

Xa ucinga RU izuza ntoni yona?

What are the benefits for the government?

Xa ucinga urhulumente uzuza ntoni?

What are the benefits for the community?

Xa ucinga ikhona inzuzo eya ebahlalini?

What are the benefits for the senior traditional leader/s?

Xa ucinga ikhona inzuzo eya ngakwiNkosi?

Do you think there are any benefits for the environment in what you are doing?

Xa ucinga ikhona inzuzo efunyanwa yindalo ngalomsebenzi uwezayo?

Do you think other people in other areas would do this job without getting paid in cash but rather?

Xa ucinga abantu benye indawo bangawenza lomsebenzi bengazubhatalwa ngemali?
Do you have any recommendations of how the project could do better in future?
Awunangcebiso malunga nendlela project esebenza ngayo okanye kukhona into enoyenza bhetele?

SECTION E: Context

Who is the household head?
Ngubani intloko yekhaya? Ihlala ikhona? Xa ingekho?
Do you have a home of your own? Do you own or rent it?
Unawo umzi ongowakho? Okanye uqeshile?
Do you have any land? If yes, how is it used?
Unawo umhlaba? Ukuba kunjalo, uwusebenzisa njani?
Are you married?
Utshatile?
Is anyone dependent on you? How many people?
Ukhona umntu okanye abantu abaxhomekeke kuwe? Bangaphi?
Do you have kids? How many?
Unabo abantwana? Bangaphi?
Are they at school? Working?
Bayafunda? Bayaphangela?
What is your own education level?
Wafunda waphelela phi esikolweni?
Who else brings in money into the household?
Ukhona omnye umntu ongenisa imali apha ekhayeni?
Is this project [NLEIP] your only income?
Ingaba lomsebenzi nguwo qha ofumana kuwo imali?
What do you mostly use the money for?
Le mali uyifumanayo uyisebenzisa njani ixesha elininzi?

SECTION F: Past participants

How did you learn to do the job?
Wafunda njani ukuwenza lomsebenzi?
What were your expected benefits?
Ngoku wawuqala wawulindele ntlobo ni yenzuzo?
What actual benefits did you receive?
Wafumana eyiphi inzuzo?
How were you let go?
Wahlukana njani nomsebenzi?
What were the reasons given for being let go?
Zazisithini izizathu zokohlukana nalo msebenzi?
Do you miss anything about working with the project?
Ikhona into oyikhumbulayo ngalomsebenzi?
Do you have any recommendations for the project to be able to do better in future?
Zikhona iingcebiso onazo ezinophucula indlela esebenza ngayo project?

APPENDIX 2: Interview schedule for Rhodes and DEA staff (conducted in English)

SECTION A: Introduction

Schedule No.	
Names & Surname	
Position	
National or Provincial	
Organisation	
Date	
Place	

SECTION B: Benefits to Host Organisations

1. How have you engaged with the environmental monitors' project?
2. What led to the selection of this methodology?
3. What were the expected benefits of the project, from your point of view?
4. In your view, what benefits have been achieved, in your view?
5. How would you say these benefits were achieved?
6. What benefits do you think the project failed to achieve?
7. What do you think caused the failure?
8. Reflection on the past years
9. Do you think there are any benefits the project should strive to achieve in future?
10. Do you have any recommendations for improving, strengthening and expanding effectively in future?
11. Any challenges?

APPENDIX 3: Aptitude Test For Monitors

Monitoring point	
Name and Surname	
Known as (Nickname)	
Age, male/female	
Date of Birth	
ID number	
House number	
Electricity?	
Street name	
Village/Farm	
Chief's/Landowner name	
Headman's name	
CS Cellphone number	
Full time resident?	
Cellphone type	
service provider	
Local coverage?	Good intermittent bad No
Highest school grade	
Certificate?	
Present employer and job	
Last employer and job	
Bank Account?	
Bank name, branch number	
Registered with SARS?	
SARS number	
Other commitments?	
Current activities	
Sports or hobbies?	
Able to swim?	
Glasses?	
Any physical problems?	

Label these bottles in sequence:



The time is ten o'clock in the morning (10h00). You must go to the river and fill a bottle every 20 minutes until two in the afternoon (14h00). Take the first sample now (10h00). What times must you take the other samples?

10h00
10h20
10h40

How many bottles will you need?

APPENDIX 4: Informed Consent Form

Research Project Title:	Towards realising the benefits of citizen participation in environmental monitoring: A case study in an Eastern Cape natural resource management programme.
Principal Investigator(s):	Nosiseko Mtati

Participation Information	
<ul style="list-style-type: none"> • I understand the purpose of the research study and my involvement in it • Ndiyayiqonda injongo yoluphando kunye nokuthatha inxaxheba kwam kulo • I understand the risks and benefits of participating in this research study • Ndiyabuqonda ubungozi kunye nenzuzo yokuthatha kwam inxaxheba koluphando • I understand that I may withdraw from the research study at any stage without any penalty • Ndiyayiqonda ukuba ndingarhoxa nanini na ndifuna kwaye akusayi kubakho sohlwayo • I understand that participation in this research study is done on a voluntary basis • Ndiyayiqonda ukuba ndiyinxalenye yoluphando ngokuzithandela • I understand that while information gained during the study may be published, I will remain anonymous and no reference will be made to me by name, site or village name • Ndiyayiqonda ukuba nangona olulwazi lungapapashwa akukho nto iyakuthi ibhalwe ngegama lam okanye ibhekise kum nangeyiphi na indlela • I understand personal information may be used • Ndiyayiqonda ukuba ulwazi ngesiqu sam lungasetyenziswa • I understand and agree that the interviews will be recorded electronically and stored on a computer • Ndiyayiqonda kwaye ndiyavuma ukuba oludliwano-ndlebe luzakushicilelwa lugcinwe kwi-computer • I understand that outcomes of the research will be shared with me after the analysis • Ndiyayiqonda ukuba kwakwabelwana nam neziphumo zoluphando emveni kohlalutyo lwazo • I understand that I may ask to be acknowledged as a contributor to the study • Ndiyayiqonda ukuba ndingacela ukubandakanywa njengomntu obenegalelo koluphando • I confirm that I am not participating in this study for financial gain • Ndiyaqinisekisa ukuba andithathi nxaxheba kuba ndijonge inzuzo eyimali 	

Information Explanation	
The above information was explained to me by: (Nosiseko Mtati)	
Olulwazi lungasentla ndiluchazelwe ngu:	

The above information was explained to me in English [IsiXhosa] and I am in command of this language:

Lonke olulwazi lungasentla ndicaciselwe ngesiXhosa njengolwimi lwam lokuzalwa

Voluntary Consent

I,

hereby voluntarily consent to participate in the above-mentioned research.

Ndinika imvume ngoluhlobo yokuba ndiyinxalenye yophando olubhalwe apha ngasentla ngokuzithandela

Signature:

Sayina

Date: / /

Umhla

Investigator Declaration

I, (Nosiseko Mtati), declare that I have explained all the participant information to the participant and have truthfully answered all questions ask of me by the participant.

Ndiyazivakalisa ukuba ndicacise ngokunyanisekileyo lonke ulwazi kulomntu othatha inxaxheba kwaye ndiyiphendule yonke imibuzo

Signature:

Sayina

Date: / /

Umhla