The potential of social learning to upscale the Community Based Water Quality Management (CBWQM) process: A case study of the Mpophomeni and Baynespruit Enviro Champs project

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Declaration

I know that plagiarism (using another's words and pretending they are my own) is wrong. In order to make 100% sure that I have not unintentionally plagiarised, I have run my work through a text-matching software programme.

I, Nkosingithandile Sithole am therefore able to declare that this thesis is my own work, and that that where I have drawn on the words or ideas of others, these have been acknowledged according to Departmental referencing guidelines.

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Abstract

Water is an essential component of human survival, with a wide variety of uses such as washing, cooking, drinking and growing food. Covering approximately 70% of the Earth's surface, water is necessary for all human survival, and is a source of life for plants and animals. Only 0.036% of freshwater can be accessed and utilised by humans, which is not enough to support the rapidly growing population and economic development. This water is further exhausted by pollution caused by sewage leaks, littering, agricultural runoff and industry discharge which deteriorate water quality significantly. To exacerbate these water issues, the major issue of water accessibility is not directly linked to quantity but has been primarily attributed to poor water governance, at a global and local level (in South Africa). Poorly maintained water infrastructure and inadequate cooperative governance have resulted in the establishment of many Community Based Water Quality Management (CBWQM) projects in South Africa, to respond to water quality monitoring and management challenges.

The aim of this study was firstly, to investigate how social learning was occurring within two CBWQM Communities of Practice (CoPs) located in KwaZulu-Natal, Pietermaritzburg, namely, the Baynespruit and the Mpophomeni Enviro Champs project (Case Study 1 and 2 respectively), and the potential of social learning to upscale CBWQM. Additionally, it sought to identify the type of support required for the scaling of social learning outcomes in CBWQM communities of practice, along two potential scaling pathways that were identified in a national study on scaling of CBWQM: Scaling Pathway 1(Policy engagement and support) and Scaling Pathway 2 (Capacity building).

The research was undertaken as a qualitative case study approach, with data collected through semi-structured interviews, document, and questionnaire analysis to investigate social learning within the two selected case studies. The data was coded and indexed using a thematic analysis technique and an analytical framework as a tool to investigate how social learning was occurring in both case studies and explore the potential required to upscale it. The study found that there is an existing gap between policy and practice with regard to CBWQM support by government structures. Despite South African water policy advocating for public participation in water resource management, there has been limited support from government to support and resource CBWQM projects over a long period of time. To upscale the practice of CBWQM, the study found that capacity building and learning needs to be improved and better supported practically through models such as the 5Ts of learning, and through supporting CBWQM participants' learning journey to establish learning pathways for them.

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Acronyms and Abbreviations

AEN	Amanzi Ethu Nobuntu
CBWQM	Community Based Water Quality Management
CBM	Community Based Monitoring
CBO	Community Based Organisations
CMA	Catchment Management Agency
CoPs	Communities of Practice
CS	Citizen Science
DSI	Department of Science and Innovation
DUCT	Duzi uMngeni Conservation Trust
DWA	Department of Water Affairs
DWS	Department of Water and Sanitation
DWAF	Department of Water Affairs and Forestry
EPWP	Expanded Public Works Programme
GeoODK	Geographical Object Driven Knowledge
IWQM	Integrated Water Quality Management
IWRM	Integrated Water Resource Management
miniSASS	mini Stream Assessment Scoring System
MSEP	Mpophomeni Sanitation Education Programme
MSU	Msunduzi DUCT River Sewer Line Discharge & General River Pollution
NEMA	National Environmental Management Act
NGO	Non-Governmental Organisations
NPO	Non-Profit Organisations
NWA	National Water Act
RCE	Regional Centre of Expertise
RDP	Reconstruction Development Programme
SAMCS	South African Marine Citizen Science Projects
SDG	Sustainable Development Goal
UMDM	uMgungundlovu District Municipality
WESSA	Wildlife & Environment Society of South Africa
WRC	Water Research Commission
WRM	Water Resource Management
WSA	Water Services Act
WWWC	Wise Wayz Water Care

Chapter 1: Introduction

1.1 Introduction

This chapter provides an in-depth background of the context of the study, its aim and significance. Furthermore, the chapter provides a broader framing of the study in the larger context of water quality in South Africa, the challenges faced and the policy that influences water quality management and access. Thereafter, I introduce the Community Based Water Quality Management (CBWQM) projects located within KwaZulu-Natal that were part of my study.The CBWQM projects form part of the broader Amanzi Ethu Nobuntu (AEN) Programme which is introduced. The research questions are detailed and situated within the broader context of the study and within the AEN programme. Lastly, the chapter provides a summary of the key concepts of the study and detailed guidelines of what can be expected in the chapters that follow.

1.2 Broad overview of water quality and Apartheid in South Africa

"Water security depends not only on availability, but also on quality" (Zhuwakinyu, 2012, p 8). Commonly referred to as a water scarce country and amongst the 30 driest in the world, South Africa continues to face challenges of deteriorating water quality attributed to both point and non-point forms of pollution, such as industrial discharge of hazardous waste, agricultural runoff and poor farming practices, urbanisation, and afforestation (Abbaspour, 2011; Zhuwakinyu, 2012). The root of some of the water quality issues faced in South Africa today can be traced back to the Apartheid era, with its discriminatory laws which privileged white populations and deprived black people. A recent study by Jegede and Shikwambane (2021) has detailed the impact of the inequalities caused by the apartheid laws on water access and service delivery. The ruling laws at the time, included the Irrigation and Conservation of Water Act 8 of 1992, gave white farmers water rights, limiting water access for black populations. Another discriminatory law was the 1913 Land Water Act, which not only displaced black populations from urban land, but denied them access to water infrastructure. Programmes implemented to address these inequalities at the time, were ineffective as they benefitted the poor white populations as opposed to benefitting the poor black groups (Jegede & Shikwambane, 2021).

Despite apartheid having ended, issues of poor water access linked to inadequate service delivery and in some rural communities' poor water quality still persist for black population groups (Jegede & Shikwambane, 2021). According to Bwapwa (2019), failing and

unmaintained sewage infrastructure have continued and have led to increasing water pollution in the country. This is attributed to a growing population in rural and semi-urban areas which has increased pressure on the pre-existing water and sewer infrastructure. Subsequent to this, untreated wastewater and sewage becomes unlawfully discharged in water bodies which contaminates the water. According to Griffin et al. (2014), the release of untreated sewage effluent within water is amongst the most recognised contributors to worsening water quality in South Africa. Sewage effluent increases the nutrient levels within a water body which leads to high pathogen levels. It is evident that there is an urgent need to improve South Africa's waste treatment technology through investing in skilled capacity particularly at a municipal level to operate, manage and maintain the sewage infrastructure in rural communities (Edokpayi et al., 2020 ; Griffin et al., 2014 ; Montwedi et al., 2021). There is also much work that needs to be done to realise the effect of the National Water Act (NWA) 36 of 1998 enacted post-apartheid to rectify the inequalities of the past (Nnadozie, 2011).

Linked to sewage effluent is eutrophication, also flagged as a commonly recognised issue contributing to deteriorating water quality. Griffin et al. (2014) explained that eutrophication is a process that occurs due to a high nutrient load in a water body. This can be caused by human induced or natural activities such as unsustainable agricultural practices which can include the use of pesticides and herbicides that seep or leech into nearby water sources, resulting in algal bloom and subsequently loss of aquatic flora and fauna. Poorly maintained sewage plants as aforementioned, and a growing population that is not supported by existing sewage infrastructure potentially leads to eutrophication. This issue is more common within informal settlements in cities and peri- urban areas which are densely populated. This dense population is attributed to rapid urbanisation, due to the migration of large populations to urban areas in hopes for access to better job opportunities and quality of life. Industrialisation is also singled out as a contributor to rapid population growth in peri-urban areas, which is due to rapid industrial growth and development for economic growth and development (Griffin et al., 2014).

Algal and macrophyte blooms from eutrophication disturb the ecological health of a water body, which produces toxins that alter the taste and quality of water (Griffin et al., 2014). Known as a mining country, South Africa's other top threat to water quality is what is known as Acid Mine Drainage (AMD). Mostly found in gold and coal mining areas, this process occurs as a result of a reaction of chemicals and minerals such as sulphide minerals. This results in lower pH levels and high salinity which makes the water quality toxic. An additional issue

linked to this problem is that it is expensive to treat and consequently affects both groundwater and surface water (Griffin et al., 2014). The abovementioned threats to water quality do not only implicate on ecosystem health of the environment, but also pose a critical threat to human health and life. This is because when water is contaminated, it becomes unsafe to drink or use (Bwapwa, 2018). A study conducted by Lewin et al.(2017) to investigate the impact of unsafe drinking water, poor sanitation and hygiene practices found that 13 434 deaths owing to these unsafe practices were attributed to diarrheal diseases. Many households in South Africa, particularly in rural areas still face challenges related to sanitation and water service delivery. Lewin et al. (2007) noted that there was a significant variation between households in KwaZulu-Natal, Limpopo and the Eastern Cape in terms of water access and availability of sanitation facilities. According to Lewin et al. (2007), a total of 12.9% of households in KwaZulu-Natal, at the time the study was conducted, still relied directly on natural water sources such as streams and rivers for their water supply.

Although the Lewin study dates to more than 10 years ago, it is still relevant for exploring the issues that exist despite being post apartheid, for many South African communities are still challenged with water access and proper sanitation delivery. A recent study by Jegede and Shikwambane (2021) alludes to this stating that "arguably, inequality regarding service delivery, particularly water service delivery featuring in the apartheid regime, continues afterwards" (p. 8). Following the official end of apartheid in 1994, measures have also been adopted to respond to unfair discrimination relating to water access; however, there has not been much considerable change. Although South Africa has well-documented water laws, which emphasises the right to water for all, this legislation needs to be implemented (Griffin et al., 2014).

1.2.1 Water legislation in South Africa

After 1994, great effort was made to ensure that the inequalities and racial discrimination rooted in Apartheid relating to water access and service delivery were rectified through the enactment of new water policies that ensured water access for all (Heleba, 2011; Hove et al., 2019; Jegede and Shikwambane, 2021). Whether the evidence of the impact of the legislation being implemented is visible, is still being questioned, as many South Africans who were disadvantaged before still face the same challenges of poor service delivery today (Jegede & Shikwambane, 2021). Within the South African Constitution (1996), is the Bill of Rights of Rights, which is basis of democracy for South Africa and contains all the human rights to

ensure that citizens live a life of equality, freedom, and dignity. In Chapter 2 of the Constitution, Section 27(1)(b), it states that everyone has the right to adequate water access. In promotion of equality and non-discrimination, Section (9)(2) of the Constitution further advocates that people should enjoy their rights and freedom fully. It also advocates that 'judicial and other measures' should be taken to ensure that these rights are implemented to ensure equality for all. The aim of this legislation is to ensure that all past injustices caused by Apartheid are rectified to so that there is equal access of water and adequate service delivery for all individuals (Jegede & Shikwambane, 2021).

The Water Services Act 108 of 1997 (WSA) aims to ensure that Constitutional law is enacted. The preface of WSA acknowledges the rights of access to basic water supply and sanitation facilities as necessary for human and environmental well-being. The policy goes on to state in Section 3(1) "everyone has a right of access to basic water supply and basic sanitation." (quoted in Heleba, 2011, p. 14). In support of this, Section 3(2) of the policy highlights that all water service institutions should take it upon themselves to bring these rights into action, by taking the necessary steps. The WSA ultimately in Section 1 and 3, provides a right to access a minimum of 25 litres of water per person per day. Coupled with the WSA is the National Water Act 36 of 1998 (NWA). This Act is the governing Act that decides and provides regulatory guidelines on how water should be managed, used and distributed in South Africa. This national policy provides guidelines to WSA on how it should be effected (Heleba, 2011). The NWA is part of the National Environmental Management Act (NEMA) 107 of 1998, which was created to enforce section 24 of the South African Constitution, known as the environmental right (Masindi & Dunker, 2016). It states that "everyone has a right to an environment that is not harmful to their health or wellbeing, for the benefit of present and future generations" (The Constitution of the Republic of South Africa, 1996, p. 9).

On a local scale, the Department of Water and Sanitation (DWS) governed by NWA and WSA is responsible for creating and aiding an environment for proper water use and management through the abovementioned policy. This means that the Minister of Water Affairs is in charge of managing water resources in South Africa. Masindi and Dunker (2016) highlighted that water should be managed integratively to ensure efficient and sustainable water use, especially because water is such a scarce resource in South Africa. Water management in South Africa is divided into 19 water management areas (WMAs), which are assigned Catchment Management Agencies (CMAs), as outlined in Chapter 7 of the NWA. CMAs manage water resources at a catchment level and are responsible for devising strategies that will guide how water is used,

managed and conserved for each catchment. CMAs advocate for stakeholder engagement (from community level) in water resource management and decision-making, to ensure that the needs of all stakeholders who use water are met in a just and equitable manner (Masindi & Dunker; NWA, 1998). The importance of participatory water quality management and stewardship by citizens in South Africa, is becoming increasingly important to protect and maintain the health of our water resources (Abbaspour, 2011).

1.3 Context of the study: An introduction to Community Based Water Quality Management (CBWQM) in South Africa

South Africa has adopted an Integrated Water Resource Management (IWRM) policy and approach, which is aimed at improving water quality and management through stakeholder collaboration in Water Resource Management (WRM) (Lotz-Sistika et al., 2022). With South Africa being categorised as a water scarce country globally, with less than 1700m^3 per capita of freshwater available, there is an urgent need to improve water management and use. While most of the water management responsibilities lie with the government, community participation is needed in order to meet the resource limitations faced by the government, and to align with the democratic imperatives discussed above. These limitations include physical infrastructure, technical staff and insufficient funding (Adom and Simatele, 2022 ; Nare et al., 2011). IWRM advocates for community involvement in water management and is defined as a "holistic approach that seeks to integrate the management of the physical environment within the broader socio-economic and political framework" (Claassen, 2013, p.323). As mentioned earlier, the NWA also emphasises the importance of public participation in water resource management, particularly within the catchment management strategy approach (Masindi & Dunker, 2016).

A practical demonstration of public participation in water resource management is Community-Based Water Quality Management (CBWQM). CBWQM is a form of Community Based Monitoring (CBM), which emerged as a response to shared water quality concerns in the community. Borrowing from the definition of CBM, CBWQM refers to a collaboration of stakeholders who come together to address a commonly shared issue (Buckland-Nicks et al., 2016; Naiga, 2018). CBWQM, also referred to as Community Based Water Management Systems (CBWMS) by Naiga (2018), is likely to be enacted in developing countries as a result of poor water governance relating to service delivery. This is the case for South Africa, with many rural communities facing challenges of poorly managed and maintained water and

sanitation infrastructure (Jegede & Shikwambane, 2021). According to Lotz-Sisitka et al. (2022), there is a diverse range of CBWQM projects operating in South Africa, which range from government to civil society, to academically led and non-profit organisation supported CBWQM projects. This is the trend as CBWQM projects often involve a diverse range of stakeholders who work together to support CBWQM projects, depending on their scale and purpose. The scale of a project can often determine the type of support it receives.

A national review of CBWQM projects in South Africa has been conducted by Lotz-Sisitka et al. (2022). The review found that national CBWQM projects were more likely to be supported by government as opposed to local projects, which were often community driven and frequently supported by institutions such as non-profit organisations (NPOs). CBWQM projects face a range of challenges in South Africa, the most major being inconsistent funding (Lotz-Sisitka et al., 2022). This affects the longevity of CBWQM projects, which often get cut short due to short funding cycles. This has a ripple effect on citizens involved in the projects who rely on these projects for employment and their livelihoods. The majority of citizens who are involved in CBWQM projects do not participate at a volunteer level, but rather at a 'job seeking or opportunity level'. This affords them the opportunity to receive a stipend for the work they do in well-funded CBWQM projects (Lotz-Sisitka et al., 2022). To date, no sustainable long-term solution has been identified to resolve this funding issue; it is therefore imperative that further research be conducted to explore the potential ways that CBWQM projects can be further supported and upscaled in South Africa.

Environmental NPOs have contributed significantly to improving the water quality of the most polluted water sources in South Africa through CBWQM. One of the NPOs doing CBWQM work in KwaZulu-Natal is the Duzi uMngeni Conservation Trust (DUCT), which was founded in 2006 by canoeists. Driven by their concern of the water quality of the uMngeni and uMsunduzi Rivers, the canoeists decided to create an organisation that could respond to this issue by working in collaboration with local stakeholders. DUCT aims to improve the health of the uMsunduzi River through raising awareness of the health status of the river using environmental education and engaging the community in river health projects (Taylor & Cerenzio, 2018). DUCT has engaged in various initiatives that have adopted citizen science as an approach to improving the water quality of the uMngeni and Msunduzi River. One of the most well-known CBWQM programmes is the Mpophomeni Enviro Champs, which gained much popularity due to the excellent work of the Enviro Champs which have played a role in raising the profile of CBWQM work and upscaling it.

1.3.1 Scaling in CBWQM

Scaling plays a critical role in enhancing the work of CBWQM projects, as it has potential to support CBWQM practices. A complex term which has varied meanings, scaling can simply be defined as a learning process that extends activities from a small scale to a larger scale (Lotz-Sistika et al., 2022). As explained further in the Lotz-Sisitka et al. (2022) study – which was a study conducted in a partnership between DUCT, Rhodes University, Ground Truth and Sustainable Value Creation partners – scaling occurs through various mechanisms, namely, scaling objects, scaling subject, scaling site, scaling pathway, scaling resources, and scaling drivers. Scaling objects can be defined as the specific activities being scaled, which can include norms and values, principles and social learning. Scaling subjects are individuals who are carry out the scaling process, these include NGOs, researchers, policy makers and community members, while a scaling site is the locational context a particular activity is moving from and to. A scaling pathway is the mechanism in which the scaling object travels, this can happen through various contexts or environments such as those found in and across CBWQM projects. Factors that enable scaling like funding, frameworks and policies are referred to as scaling resources. These enable scaling to occur at a wider scale, through offering various forms of support to CBWQM projects. Amongst other important scaling drivers are partnerships that enable scaling to occur; these are often across organisations who have been supporting an activity like CBWQM across organisations over a period of time (Lotz-Sisitka et al., 2022). Scaling mechanisms serve as indicators of areas that need immediate attention within CBWQM practice to better support it and ensure its success.

Since my research is linked to the DUCT who were a lead organisation in the abovementioned scaling research, there are two scaling mechanisms that I focus on in this study, as identified in the Water Research Commission (WRC) national review of CBWQM projects mentioned earlier (Lotz-Sisitka et al., 2022). The first is Scaling Pathway 1, which focuses on political economy and political support. This scaling pathway is aimed at engaging policy (at a global, national and local) related to water resource management and establishing a political economy to better support the practice of CBWQM.

I also focus on Scaling Pathway 3, which focuses on capacity development. This scaling pathway is aimed at providing formal and non-formal training and support to individuals involved in CBWQM work to develop their technical skills and increase their knowledge of water resource management. This is with the intention of not only meeting CBWQM project goals, but the personal and professional development of CBWQM participants (Lotz-Sistika et

al., 2022). These scaling pathways and mechanisms were identified and developed as an analytical framework for in-depth analysis of the CBWQM projects in the broader WRC project discussed in Section 1.5 below. Figure 1.1 below depicts the analytical framework for scaling mechanism and pathways. Scaling is an important tool that can be used to strengthen and support CBWQM practices in KwaZulu-Natal (Lotz-Sisitka et al., 2022). Two of these CBWQM practices that this study focuses on are the Mpophomeni Enviro Champs project (Case Study 1) and the Baynespruit Enviro Champs project (Case Study 2) presented in Section 1.3.2 below.

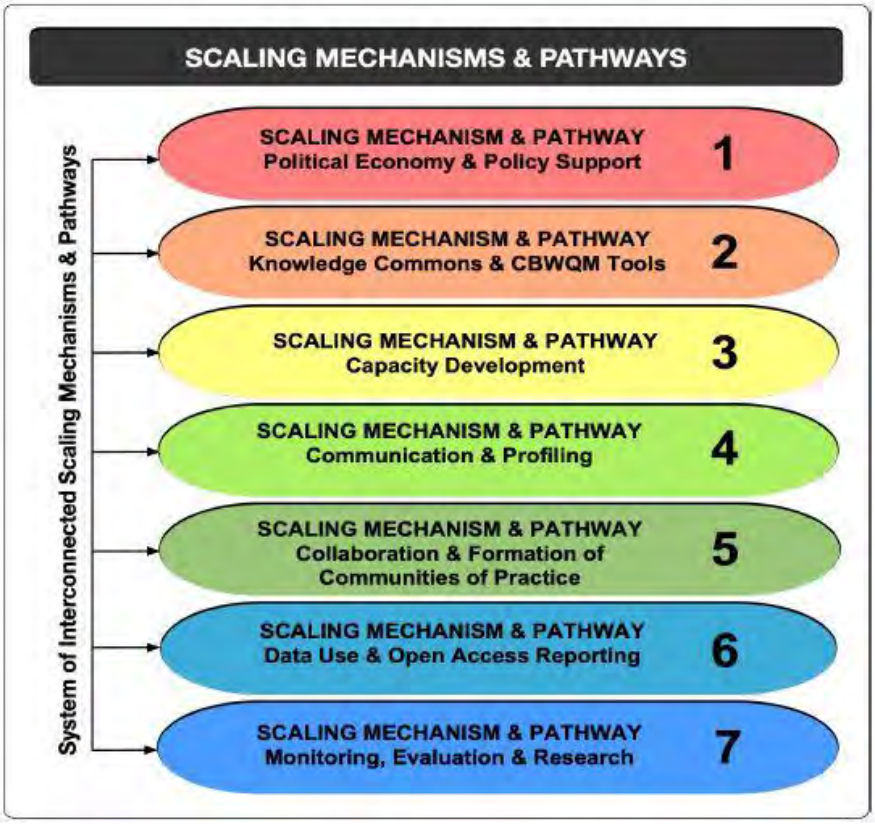


Figure 1.1: Analytical framework for scaling pathways and mechanisms (Lotz-Sisitka at al., 2022)

1.3.2 Amanzi Ethu Nobuntu (AEN) programme

The Amanzi Ethu Nobuntu (AEN) programme was introduced by the South African government as a response to the COVID-19 pandemic that exacerbated the already high unemployment rate amongst youths, in South Africa. The programme was aimed at creating employment for youths within South Africa through a citizen science approach, funded by the Department of Science and Innovation (DSI). In 2020, DUCT was appointed as an implementer of phase 1 of the AEN programme and was responsible for hiring 300 youths to do Enviro Champ work for three months. The AEN project was also a pilot for the WRC scaling research

(Lotz-Sisitka et al., 2022) in which DUCT was a lead implementer. Through this opportunity DUCT was able to identify and involve more than 10 partners within the uMngeni Catchment who would fund and support already existing and new CBWQM teams. An example of an existing project supported by the AEN programme is the Mpophomeni Enviro Champs Project, which is explained in detail below (Section 1.3.3). The AEN programme has played a catalytic role in upscaling the CBWQM practice within the uMsunduzi-uMngeni Catchment and South Africa. Further it served as an avenue to trial a blended finance approach to support CBWQM projects (Lotz-Sisitka et al., 2022).

1.3.3 Community based water management initiatives /projects

Case Study 1: The Mpophomeni Enviro Champs Project

Located right upstream from Midmar Dam, in the uMngeni Catchment, is the Mpophomeni community. This community has been challenged with poor service delivery linked to improper maintenance of water and sanitation infrastructure, with causes rooted in Apartheid discriminatory laws discussed earlier. This has led to water quality related issues such as spilling manholes, poor sanitation, and improper waste management. Consequently, the water quality of many local streams has deteriorated in the Mpophomeni township and subsequently impacted on the health of one of the most important dams in South Africa known as Midmar Dam. According to Lotz-Sisitka et al. (2022), despite the Mpophomeni community making up only 3% of Midmar's catchment area, it is reported to have contributed 51% of E. coli and 15% of phosphorus pollutants into Midmar in 2014. The concern for the well-being of critical water resources such as Midmar Dam coupled with the need to ensure quality of life of community members in Mpophomeni, led to the formation of a number of community-led projects. The most popular and successful one is the Mpophomeni Sanitation Education Programme (MSEP). Born in 2011 as a partnership between DUCT and the uMgungundlovu District Municipality (UMDM), the aim of the project was to support and capacitate a group of Enviro Champs with the skills to respond to the persistent water quality related issues, particularly surcharging sewers and leaking manholes faced by the Mpophomeni community (Ward, 2016). This citizen science-based water quality management project has played a crucial role in educating and raising awareness of water quality issues in the Mpophomeni community through various community engagement activities such as door-to-door education, enviro-clubs or eco-clubs and through collecting and monitoring water quality data using citizen science tools. The citizen science tools used by the Enviro Champs included miniSASS, the

clarity tube and the use of cellular apps such as Geo ODK to collect, monitor and store water quality data (Lotz-Sistika et al., 2022; Ward, 2016). The Enviro Champs project has gained popularity both locally and internationally due to its ability to provide employment for local community members and the impact it has had in encouraging other areas to adopt the Enviro Champs model (Lotz-Sistika et al., 2022). The Mpophomeni Enviro Champs project has currently been put on hold, due to no funding. This is the case for majority of CBWQM projects in South Africa, that are faced with the challenge of inconsistent funding, which impacts on the sustainability of the project and on the livelihoods of community participants involved in it. In 2020, the AEN programme adopted the Mpophomeni Enviro Champs project as one of the existing CBWQM initiatives it would support, and this was crucial in allowing the Enviro Champs to continue their work. The funding from this programme was able to provide employment for the Enviro Champs for a period of three months in phase 1 of the programme, and on an ad hoc basis thereafter until October 2022.

Case Study 2: The Baynespruit Enviro Champs Project

The Baynespruit Enviro Champs (case study 2) was a new CBWQM project supported through the AEN programme which consisted of three teams (made up of 32 individuals) who were located in the Sobantu and Eastwood area, within KwaZulu- Natal. Based on the Mpophomeni Enviro Champs model, the teams were responsible for conducting monitoring activities, such as illegal dumpsite monitoring and leaking sewer monitoring. In addition to this, were community engagement activities like door-to-door education in these respective areas, all in an effort to improve the water quality of the Baynespruit River. Due to the project being recently developed, there is limited literature on it. Figure 1.2 below is a map that depicts the geographical location of the project areas that the respective teams worked in.

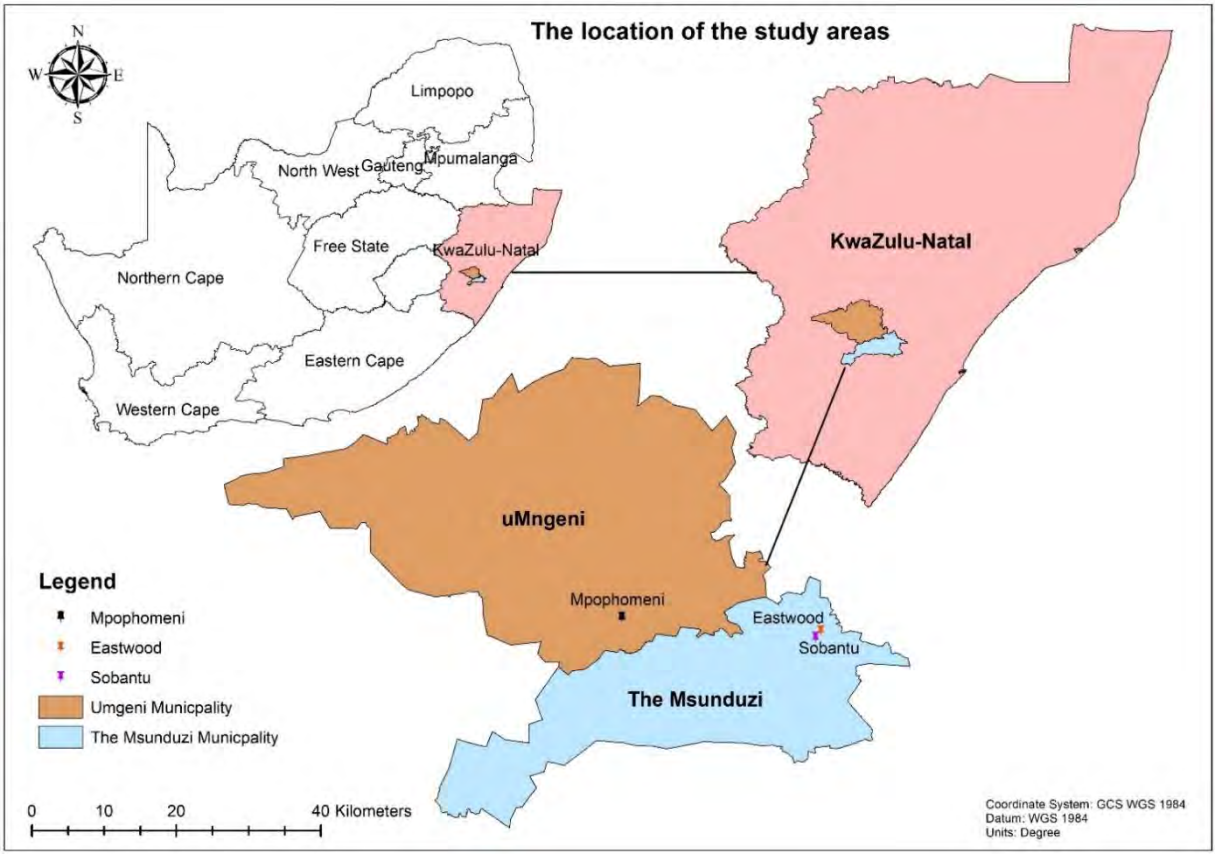


Figure 1.2: Map showing locality of case study areas (Source: map produced by Nkosi Sithole using Geographical Information System (GIS) data from Duzi uMngeni Conservation Trust (DUCT)).

1.4 Researcher positionality

I was employed as a project manager at Duzi uMngeni Conservation Trust (DUCT) in which I was responsible for managing two CBWQM projects within the AEN programme, namely the Mpophomeni and Baynespruit Enviro Champs project. DUCT was appointed as an implementer of the AEN programme and was tasked by the DSI to employ 300 youth. Within my role as a project manager, I was responsible for coordinating and facilitating training that capacitated the teams with practical skills and knowledge to conduct CBWQM activities. I was also responsible for ensuring that the teams were equipped with resources such as data for internet access and WhatsApp communication and airtime for telephone calls. The teams were also provided with protective clothing for fieldwork and citizen science tools to perform their daily environmental and biomonitoring activities. Training covered topics ranging from citizen science tool use, climate change and water resource management, to capacitate teams with the knowledge and skills to perform their work-related tasks. Further I was responsible for overseeing the teams' weekly activities, which included addressing challenges and ensuring team harmony.

Through working as a project manager for two years, I was able to observe and learn from the dynamics of a multi-stakeholder approach to water resource management. Furthermore, working with these teams helped build a sense of trust and a relationship with the team members. I mention the above because the relationships built with the CBWQM participants are an important aspect of data collection, specifically in the interviewing process which is one of the data sources applied in this study that require a level of openness from the interviewee which can only be built through trust overtime. Within DUCT, I also worked as a research assistant on the Water Research Commission (WRC) project mentioned above and discussed further in Section 1.5 below. Within this role I was responsible for contributing to a collaborative project known as the *Research into Alignment, Scaling and Resourcing of Citizen Based Water Quality Management (CBWQM) to Realising the Integrated Water Quality Management Strategy Project* (Lotz-Sisitka et al., 2022), in which I wrote relevant case studies of CBWQM projects in the uMsunduzi-uMngeni Catchment. This role positioned me well to observe and gain an understanding of how CBWQM projects were operating across South Africa and potential scaling pathways that could be explored for the practice of CBWQM.

The project manager role within DUCT also positioned me well as I was recognised by the team members (CBWQM participants) and community as a partner and team collaborator, rather than simply a project manager which made the interview process easier as they were open to sharing truthfully and honestly in response to the questions I posed. My positionality also simplified the selection process for the case studies to use in my research, as I was already exposed to CBWQM projects through my role at DUCT and had existing relationships with the abovementioned CBWQM teams. Lastly, I recognised the opportunity to conduct this study within DUCT using active CBWQM projects (real life case studies) that I was exposed to, as an opportunity to feed back the findings from the research into the two projects. DUCT also encourages staff to become involved in both research and practical projects which made permissions for conducting the research easy. Being able to observe the potential impact my study could make at a micro level made my research experience more purposeful and is what fuelled me to reach the completion phase of this study.

1.5 Research purpose

Research into Alignment, Scaling and Resourcing of Citizen Based Water Quality Management (CBWQM) to Realising the Integrated Water Quality Management Strategy Project (Lotz-Sisitka et al., 2022) is a WRC project which used an action research orientated approach, aimed

at exploring the existing flaw between policy and practice relating to public engagement and participation of citizens in Integrated Water Quality Management (IWQM). Further, the project sought to investigate reasons for the inadequate support of scaling best practice CBWQM projects in South Africa (Lotz-Sisitka et al., 2022). The project was aimed at identifying water related policy that supported CBWQM and sought to build closer associations with IWQM at a national (NDP) and international policy (the Sustainable Development Goals) levels. The project used a qualitative case study-based approach to investigate different CBWQM projects in South Africa. It also conducted an in-depth literature review on CBWQM in South Africa and related policy for more information on the dynamics of CBWQM in South Africa.

My study forms part of this broader study, and builds on existing data, specifically the Question-based CBWQM Project Review Tool[1] (see section 3.4.2), which was completed by participants who entered information about the CBWQM projects they were involved in. The Questioned-based Online Review Tool followed a two-step process, with the first step being an in-depth analysis of 10 CBWQM projects. The Question-based Online Review Tool was then refined and used to gather more information on CBWQM projects. In this study I analyse the full set of data sourced from this tool, which was a total of 31 questionnaires (representing CBWQM projects in South Africa) with a particular focus on Scaling Pathway 1 (Policy support and engagement) and Scaling Pathway 3 (Capacity building) as a potential scaling mechanism for the practice of CBWQM. Furthermore, the questionnaire data was used as an additional source to inform the research questions outlined in Section 1.6 (see Section 3.4.2).

1.6 Research questions

Main aim and questions:

The aim of this study is to investigate social learning in CBWQM communities of practice and the support required to scale aspects of social learning in CBWQM communities of practice.

Sub questions:

(i) How are social learning processes taking place in CBWQM communities of practice?

(ii) What are the outcomes of the social learning in CBWQM communities of practice?

[1] CBWQM Project Review Tool: refers to a google form (in the form of a questionnaire) used within the WRC project aimed at CBWQM participants with the purpose of capturing information about CBWQM projects in South Africa. (see Appendix E).

(iii) What support (nurturing, resources, participation networks, and other forms of support) are enabling the social learning in these communities of practice and how can this potentially enable scaling of the CBWQM outcomes and practices via capacity building and policy aspects?

1.7 Definitions of key concepts in this study

This study was framed around CBWQM, therefore the key concepts for this study are primarily from the theoretical framing (Communities of Practice theory) of the study and linked to how social learning is occurring in the two case studies.

Social learning: Reed et al (2010) defined social learning as a three-step process that involves a change in one's behaviour at an innate level. This change in behaviour must be visible and inspire or influence change in others. Lastly, the learning must occur within a group setting (social network). Within the environmental sector, a major aspect or intention of social learning is the need to combine a diverse range of ideas and range of stakeholders to solve complex environmental issues. This diversity creates a space for innovative ideas to occur (Wals et al., 2009).

Community Based Water Quality Management: This is a form of Community Based Monitoring (CBM), which refers to stakeholders who collaborate to address a commonly shared issue of water quality management (Lotz-Sisitka et al., 2022).

Community of Practice: Founded by Etienne Wenger and Jean Lave, the term 'communities of practice' (CoPs) refers to a group of individuals who share a common interest, who collaborate and engage to develop an understanding of the shared issue (Pryko et al., 2017). According to Mohajan (2017) for a community to be regarded as a CoP, it must exhibit the following traits: a domain, culture and shared practice (Sánchez-Cardona et al., 2012; Vincent et al., 2018).

Enviro Champs: This refers to individuals who are responsible for championing environmental health through the engagement and application of a diverse range of citizen science tools, which inform and educate the public on water quality (Ward, 2016).

Citizen science: This is simply defined as public engagement in scientific research**.** This means that everyday citizens can engage in scientific research using a variety of what is known as citizen science tools. These include, but are not limited to, a mobile app that captures citizen science data or water quality monitoring tools such as miniSASS, velocity plank or clarity tube (Hulbert et al., 2016; Miller-Rushing et al., 2012). There is a diverse range of citizen science

projects in South Africa, that create a vast number of opportunities for the public to engage in. These include observing bird migration and identifying or mapping fungi (Hulbert et al., 2016). Citizen science is recognised as avenue to improve scientific literacy in citizens and as a tool to build an innate sense of advocacy for the environment (Weingart & Meyer, 2021).

Scaling: This refers to expanding the level at which something is occurring or taking place, which can be at a geographical level or level of impact. The focus in this current study is the scaling of the practice of CBWQM. As mentioned in Section 1.3.1, scaling can take place through various mechanisms which have been identified by Lotz-Sisitka et al. (2022) as scaling objects, scaling subject, scaling site, scaling pathway, scaling resources and scaling drivers. In the context of CBWQM, scaling objects refers to scaling of factors such as CBWQM activities, shared norms, and values or "way of doing things" occurring in the CBWQM CoP. Scaling subjects refers to stakeholders who implement the scaling process. This ranges from NGOs such as DUCT (mentioned in Section 1.3.2) , local and national water authorities and community members. Scaling context refers to the geographical context in which a particular practice or activity is taking place. Scaling pathway refers to the medium in which the scaling is taking place, which can range from political support to capacity building. Lastly, scaling resources refers to those factors that enable scaling to occur, such as funding for CBWQM projects and or political support from water authorities.

1.8 Thesis structure

This thesis is made up of five chapters, outlined below. **Chapter 1** provides a summary of the background and context of the study, which includes an account of water quality in South Africa (pre and post-apartheid) and the policy that governs how it is managed. Further, the chapter provides details on my positionality in the study, the aim and research questions that will be addressed and provides an overview of various concepts that will be explored in the forthcoming chapters.

Chapter 2 presents the theoretical framing used in my qualitative case study research. The focus is on water (water quality and access) in South Africa and the national and local policy which governs. Thereafter I provide a detailed literature review on CBWQM in South Africa and the factors that enable and constrain this practice. Finally, I unpack the Communities of Practice (CoP) theory in relation to social learning and provide practical examples of this in action through literature.

Chapter 3 provides a detailed and logical research methodology that was applied to conduct this study. The study formed part of a bigger project (outlined in Chapter 1) and therefore was intended to further investigate and explore scaling pathways previously created and proposed to upscale and support CBWQM in South Africa. This chapter further details the process of data collection and the tools used to source this data coupled with the analysis process applied. An analytical framework was created using concepts from Communities of Practice theory and conceptual framework presented in Chapter 2. The chapter closes with an account of the ethical considerations of the study, data validity and trustworthiness.

Chapter 4 is the data presentation chapter which provides results from the initial phase of analysis conducted to identify emerging themes from the data through application of the analytical framework outlined in Chapter 3. This analytical framework was also used to present the data within this chapter to address the research questions presented in Chapter 1.

Chapter 5 provides an in-depth discussion of the findings from the data presented and analysed in Chapter 4. Thereafter, I relate the findings of the data to the research questions outlined in Chapter 1 and to the literature presented in Chapter 2. Finally, several recommendations and a conclusion to the study are offered.

1.9 Conclusion

In this introductory chapter I have presented a summary of the broader contextual background in which my study is located. I have provided background on the broader project in which my study is situated in as well as the purpose of my study in relation to this. Furthermore, I have provided a short overview of water quality in South Africa and legislation that governs it, which is further elaborated in Chapter 2. This chapter also presents the key concepts underpinning the theoretical and conceptual framing of the study, as well as detailing what to expect in the forthcoming chapters. Chapter 2 that follows focuses on the theoretical and conceptual framing of the study and provides an in-depth discussion of CBWQM in South Africa and how it has progressed from its initial inception to date.

Chapter 2: Community-Based Water Quality Monitoring: Conceptual and Theoretical Perspectives

2.1 Introduction

In this chapter, I provide a detailed review of the literature applicable to my study as well as my theoretical framing guiding the research process. This chapter starts off by discussing the state of water quality at a local and global scale, and the factors attributing to the deteriorating water quality. It further goes on to unpack the global, national, and local policy that governs how water is managed and distributed in relation to CBWQM, and the impacts of pre-apartheid water policies on water access linked to service delivery. The chapter then introduces the Communities of Practice (CoP) theory which frames the study in relation to CBWQM projects in an attempt to show how social learning is occurring within the projects.

2.2 Water quality: Global and national context

The critical importance of water, particularly freshwater, cannot be emphasised enough, as it is the main source of life for all living things, with humans dependent on it for domestic needs such as drinking and washing (Afroz et al., 2014; Hadler and Islam, 2015; Khatun, 2017). Water plays an important role in regulating ecosystem processes, ensuring ecosystem health, and is widely used in the agricultural and industrial sectors within manufacturing processes (Usali and Ismail, 2010; Van Vliet et al., 2021). Only 0.036 % of freshwater can be used by humans and is accessible and this is insufficient to support the rapidly growing global population (Jayaswal et al., 2018; Postel, 2000). In addition to water scarcity, the health of water bodies such as rivers and lakes has become threatened due to increased agricultural and industrial activities driven by human needs which has led to rapid development and urbanisation in developed regions (Adejumoke et al., 2018).

Sewage leakages, littering, agricultural runoff and industrial discharge are identified as the main sources of water pollution resulting in deterioration of water quality (Kjellstrom et al., 2006; Viman et al., 2010). Water is polluted when untreated or harmful substances enter a water body such as a river, lake or ocean and water quality deteriorates (Ahmed & Ismail, 2018). Polluted water carries waterborne diseases such as cholera, typhoid fever and diarrhoea which pose a threat to human health (Ahmed & Ismail, 2018; Musingafi, 2014). According to Ahmed and Ismail (2018), globally, 3.1% of deaths are attributed to waterborne diseases. If the

water quality of freshwater ecosystems is not remediated, water ecosystem services will continue to diminish, and the life of humans and other forms of our living biodiversity will continue to be threatened (Van Vliet et al., 2021).

According to Chaudhry and Malik (2017) the biggest contributors to water pollution are industrialisation and a rapidly growing population. Industrialisation adversely affects the environment with the economic growth adding pressure for natural resources and ecosystem services on the environment (Aroh, 2018). Industrialisation has had both negative and positive impacts globally. Economic growth has created employment for many, but the downside is that it has led to massive population growth, subjecting the environment to great pressure to support a rapidly growing population. Economic growth, linked to industrialisation is characterised as another major contributor to worsening water quality as it has added pressure on the environment for natural resources such as water and land, to support production and manufacturing processes of industries. Industries rely heavily on water as a raw material for the manufacturing process, therefore most industries are built around water sources and pose a threat to water quality. These industries contaminate water quality through the illegal discharge of toxic effluents into water bodies. Hazardous effluents pose a serious threat to aquatic life and to human health. A total of 14000 people die due to water pollution each year. Contrary to popular belief, poor water quality is experienced in both developed and developing countries (Chaudhry & Malik, 2017).

The biggest risk to water quality is point source pollution which is referred to as pollution that comes from an observable source such as a leaking sewage line. This form of pollution can be attributed to industries and municipalities. Another factor that threatens water quality globally, is mining, urban development, and poor agricultural practices. These factors are linked to non-point source pollution, which refers to a source of water pollution which is not known or when pollution does not come from a one identifiable source. Examples of non-point pollution sources are fertilisers, pesticides and industrial waste that ends up in water sources due to runoff, leeching or seeping.

Pollutants are referred to as substances that alter the quality and, in some cases, the chemical composition of water. Pollutants can either have long or short-term effects on water quality. Chaudry and Malik (2017) stated that industrial pollution is categorised as one of the most hazardous forms of pollution to water quality and human health. Many African countries have seen rapid economic development coupled with a rapid rate of urbanisation, industrialisation

and land use for agricultural purposes. This has led to an increase in pollution in the form of waste and wastewater which is often discarded into rivers. Poorly managed wastewater produced by an array of human induced activities, is a common issue globally, but more so in developing countries. Untreated wastewater is often discarded into nearby streams, which deteriorates the water quality of primarily freshwater sources (Kanu & Achi, 2011). A regional example of a country challenged with industrial pollution is Nigeria. In developing countries like Nigeria, untreated wastewater has been linked to industrial effluents, which is attributed to rapid industrialisation and population growth. Nigeria relies on its freshwater sources such as estuaries for the majority of their drinking water supply. But the health of these freshwater sources has been compromised due to poor environmental practices affecting water quality by the local population, illegal disposal of industrial and agricultural effluent into nearby water sources. Industrial effluent is recognised as the biggest form of pollution, which impacts on aquatic ecosystem cycles, and consequently on aquatic flora and fauna. Hazardous chemicals from industrial effluent often include heavy metals, pesticides and petrochemicals, to name a few. Chemicals like heavy metals can pose a threat to human health, dependent on the quantity present in a water body which can be poisonous to aquatic flora and fauna (Kanu & Achi, 2011).

Zambia is another case of an African country challenged with industrial pollution. A legal case, known as the Nyasulu case, pertaining to industrial pollution was recently resolved by the Zambian High Court. Residents of the town of Chingola in Zambia relied on a local river for basic services such as drinking and domestic needs. The water quality of this river was compromised due to an effluent discharge, attributed to a burst pipe from a mining company. As a result, the majority of the residents fell ill, suffering from diarrhoea, stomach cramps and skin diseases (Soyapi, 2016). It is apparent from the above-mentioned examples that industries, particularly those located along water sources, are extremely hazardous as they compromise water quality and the well-being of communities dependent on rivers for their ecosystem services (Mugagga & Nabaasa, 2016).

2.2.1 Water quality in South Africa

Although accessibility to safe and clean drinking water is a Constitutional right for all South African citizens, the poor quality of our freshwater resources coupled with poor service delivery has challenged the achievability of this goal at a national scale (Edokpayi et al., 2020).

South Africa's water crisis, which includes unequal distribution and access to water resources and poor service delivery pertaining to water and sanitation, has its roots in the inequalities of the Apartheid system, which deprived a large proportion of the black population located in rural communities access to water and proper sanitation related service delivery (Jegede & Shikwambane, 2021). A practical example of such a community is the Mpophomeni area, introduced in Chapter 1 as a case study for this research. Presently, this community faces issues of surcharging manholes, leaking sewer lines and illegal waste disposal which affects the quality of water sources such as rivers, linked to poorly maintained and improperly planned sewer and water infrastructure (Lotz-Sisitka et al., 2022). Despite apartheid having ended and a new Water Act (National Water Act 36 of 1998) and Water Services Act to address the abovementioned injustices, the issue of poor water quality access remains (Jegede & Shikwambane, 2021).

To compound these issues, South Africa has a limited water supply and is considered to be a water scarce country, with an uneven and seasonal rainfall of 450 mm per year, semi-arid climate, and a limited number of physical water sources such as rivers and groundwater. These water resources rely heavily on limited rainfall for their water supply (Basson, 2011; Musingafi, 2014; Odiyo & Makungo, 2012). Bwapwa (2018) attributed the limited quantity and deteriorating quality of water resources in South Africa to pollution, a limited natural availability, a rapidly growing population, industrialisation, limited rainfall and urbanization. According to Edokpayi et al. (2020) and Soyapi (2017), urbanisation and industrialisation are anticipated to increase pressure on the available water resources, especially if measures are not taken to reduce impacts of these developments on the environment. Edokpayi et al. (2020) noted that due to poor service delivery and management of water resources by municipalities in South Africa, many communities in developing countries have resorted to using renewable water resources, like springs and underground water as their water supply. According to Colvin et al. (2016), high importance is placed on protecting, conserving, and properly managing our water resources to support a growing population due to it being severely threatened by pollution. This is attributed to most of our freshwater sources, often the most vulnerable to pollution, being utilised to service industries, the agricultural sector which uses up to 60 to 62% for irrigation purposes and households in urban areas use an estimated 30% for domestic use (Basson 2011).

In essence, South Africa relies heavily on scarce freshwater resources for its water supply, but a number of studies have indicated that the main pollution sources of our freshwater sources

are attributed to mining, industrial, agricultural, and domestic activities (Basson, 2011; Bwapwa, 2018; Musingafi, 2014; Odiyo & Makunga, 2012). It is projected that South Africa creates an estimated 450 million tonnes of waste a year, with 70% of it attributed to the mining industry. Musingafi (2014) stated that mining and industrial activities use large amounts of fresh water throughout production processes, affecting the existing limited water supply. Basson (2011) further supported this but attributes the worsening water quality in South Africa to poor sanitation service delivery. Alluding to this, Edokpayi et al. (2021) noted how poor sanitation service delivery in addition to poorly treated wastewater not only threatens the health of water sources but also that of South African citizens. Thus, protection and maintenance of wastewater treatment plants has become a core focus for improving water quality. Although the abovementioned water related issues are experienced at a local scale, global literature shows that these issues are shared by many other countries. It is therefore no surprise that global water policy such as Sustainable Development Goal (SDG) 6, targets ensuring sustainable availability and water management for all, which is discussed in detail below (Edokpayi et al., 2021).

2.3 Water governance: Global context

Water is a critical component for all living things; this includes humans, the environment and economy. We are dependent on it for a range of ecosystem services, from water for drinking, as a recreation tool for tourism and as a primary input for the production of goods and services in industries. A growing population, climate change and rapid economic development has continued to place immense stress and impact on water quality and availability, particularly in urban areas, and is likely to worsen due to these issues (Bertule et al., 2018; Cooley et al., 2014; Roman and Akihmouch, 2019). This has made the issue of water management more urgent, to ensure that water quality is available for all sectors that need it for the future. The challenges currently faced of water scarcity are likely to continue to worsen due to the effects of climate change. According to Biswas (2005), issues pertaining to water quality are bound to become more difficult to solve in the future, as they become increasingly complicated. This calls for a different approach to managing water, not as an isolated entity, by one organisation, but rather through a multisector or integrated approach that involves the collaboration of a diverse range of stakeholders (Biswas, 2005).

Although water is a freely available resource for all to use, its accessibility, quality, and quantity has been restricted and unequally distributed. The shortage of water globally has led

to various political tensions and conflicts, which have been exacerbated by a rapidly growing population and economy which places additional stress on scarce water resources (Molobela & Sinha, 2011). According to Cooley et al. (2014), water scarcity is a commonly shared issue globally, but Jimenez et al. (2020) and Cooley et al. (2014) argued that the global water scarcity faced today, cannot be attributed to a shortage of physical water resources. Rather it should be attributed to the mismanagement of water resources by water governance structures, that is, local, national and regional water authorities. This argument has been further supported by Organisation for Economic Co-operation and Development (OCED) (Jimenez et al., 2020). This is caused by numerous socio-economic factors such as power inequalities, poverty and unequal distribution of water resources.

According to Bertule et al. (2018), water governance can be defined as the policies that are implemented which ensure equal distribution of water to all, in a fair and just manner. In response to poor water governance, the Integrated Water Resource Management (IWRM) framework was formulated, which can be defined as a collaborative approach to water management, that advocates for a multi-sectoral approach to water management and planning, as well as other natural resources such as land; its aim is ensuring societal well-being and sustainability of natural resources (Biswas, 2005). Having gained popularity in the 1990s, IWRM has gained global recognition, as policy to achieve sustainable integrated water resource management and improve water governance. The Dublin Principles on Water and Environment, later adopted in the 1992 International Conference of Water and Environment, advocated for the importance of public participation in water resource management. This was later mentioned at the infamous Rio Summit, which was a major turning point for IWRM (Bertule et al., 2018). Many countries have since benefitted from IWRM, which is regarded as a systematic process of achieving sustainable water management, rather than a means to an end (Bertule et al., 2018).

The IWRM framework is incorporated in Target 6.5.1 of Sustainable Development Goal (SDG) 6, which summons all countries to implement IWRM at all levels, including across countries. The fulfilment of this goal is tracked by indicator 6.5., which assess how this policy is implemented (Bertule et al., 2018). According to the United Nations (2018) report, IWRM urges governments to consider how different sectors are linked by their water usage and reliance, and how these linkages can consequently lead to integration of water management.

In 2015, 193 members of states from the United Nations (UN) gathered work towards building a sustainable and poverty free world for all in 2030, known as the 2030 Agenda for Sustainable development. The 2030 Agenda formulated 17 Sustainable Development Goals (SDGs) that would guide countries globally on taking actionable steps to meet the goal of a sustainable world. This kind of world can realise sustainable economic development without harming the environment and ensure equal rights (equal access to opportunities) and gender equality for all (Cole et al., 2018; Graham & Taylor, 2018; United Nations, 2018). Of relevance to this study and of particular importance is SDG 6, which is aimed at "ensuring availability and sustainable management of water and sanitation for all" (United Nations, 2018, p. 10). Water is an essential component for development, as all sectors ranging from agriculture to technology and energy generation, rely on it for aspects of the production process. Consequently, SDG 6 underpins all SDGs as ensuring equal access and sustainability of our freshwater resources is of paramount importance if we are to realise a sustainable society, economy, and environment (United Nations, 2018). The goal of achieving safe and affordable drinking water for all by 2030, particularly for the disadvantaged, is one that poses a challenge for all countries, especially developing countries, which often have high levels of rural communities that still lack access to safe drinking water. To realise SDG 6, eight global targets that encapsulate the water cycle were created, which are applicable to all countries. These targets are:

> provision of drinking water (target 6.1) and sanitation and hygiene services (6.2), treatment and reuse of wastewater and ambient water quality (6.3), water-use efficiency and scarcity (6.4), IWRM including through transboundary cooperation (6.5), protecting and restoring water-related ecosystems (6.6), international cooperation and capacity-building (6.a) and participation in water and sanitation management (6.b). (United Nations, 2018, p. 11)

All these targets impact on water quality and quantity directly and indirectly, therefore, to understand the factors taken into consideration when tracking progress SDG 6, we need to explore them. Target 6.1 focuses on ensuring that everyone has access to safe drinking water, by 2030.

Poor access to safe drinking water is a commonly shared issue amongst developed and developing countries, who share a total of 844 million of people still lacking access to drinking water within their homes, and 2.1 billion who are challenged with poor service delivery. In relation to this, SDG 6 is committed to ensuring that "no one is left behind", meaning that more

effort needs to be directed to communities facing the most severe forms of poor service delivery and access to water. Target 6.2 is aimed at achieving access to sanitation and hygiene and end open defaecation. Although achieving accessible and suitable access to safe and clean sanitation is a globally recognised challenge, effort needs to be made to end open defaecation, particularly in rural communities who make up 90% of the global population that engages in open defaecation (United Nations, 2018). Target 6.3 is focused on improving water quality, wastewater treatment and safe reuse of water resources. This target emphasises the need to collect, treat, reuse and recycle wastewater, to conserve the limited water resources we have.

According to United Nations (2018), reusing and recycling wastewater is a useful strategy to reduce water stress and benefit the economy, society and the environment. Target 6.4 is aimed at increasing water- use efficiency and ensuring freshwater supply. Due to the globally faced challenge of water scarcity, there is a need to use water resources efficiently. This includes identifying sectors that are major water consumers and how Target 6.3 (reusing and recycling wastewater), can be applied to reduce the amount of freshwater consumption. Target 6.5 looks at implementing IWRM. This target focuses on collaboration and cooperative governance over shared water resources. Target 6.6 is about protecting and restoring water-related ecosystems, which have been heavily impacted by rapid economic and social development. This target focuses on maintaining existing water-related ecosystems which are a foundation for the realisation of most SDGs. Target 6.a looks at expanding international cooperation and capacity building. This is pertaining to financing global and national projects relation to water conservation and effective management. Of relevance to this study, Target 6.b looks at supporting stakeholder participation in water resource management, that is, involving communities in how water is managed (United Nations, 2018). It is evident from these targets that water is multi-dimensional, and requires a holistic integrated approach to manage, and potentially realise SDG 6. SDGs provide the groundwork for water related policy for all countries globally, but how water is managed in a country at a national and local scale is a defining factor that determines water accessibility and management (United Nations, 2018).

2.3.1 Water governance in South Africa

Lotz-Sisitka et al. (2022, p 134) stated that,

> it is becoming increasingly clear that South Africa faces a multi-dimensional water crisis. A looming water deficit, significant deterioration in water quality, major

governance challenges and a substantial public funding gap in the water and sanitation sector will have major impacts on social and economic development.

Despite the evidence of deteriorating water quality, poor water access, management and use, South Africa's national water policy is regarded as one of the most advanced water policies in the world and South Africa is categorised as one of a few countries globally whose constitution protects the right to water (Arden, 2016). But this has not always been the case. With a history of Apartheid which influenced how water was governed, managed and distributed, water access and linked to it, water related service delivery, looked entirely different. Under Apartheid law, there was no assigned principal government structure to manage water access and supply it to citizens. Instead, segregated homeland governments were responsible for running water service infrastructure, which was poorly managed in rural areas, populated by black people. As a result, in 1994 statistics showed that 30% of South African citizens lacked access to a sustainable water supply, with 50% with no sanitation facilities (Nnadozie, 2011). In response to these shortfalls, post-1994, the Reconstruction Development Programme (RDP) was enacted, which mandated the previously known as the Department of Water Affairs and Forestry (DWAF), now known as Department of Water and Sanitation (DWS) to ensure that all South African citizens have access to water (Nnadozie, 2011).

Chapter 2 of the South African Constitution explicitly notes in Section 27 (1)(b) that "everyone has the right to have access to sufficient food and water" (Edokpayi et al., 2020, p.189). This part of the Constitution recognises that for citizens to live a healthy life, access to clean and healthy water is fundamental. For this right to be realised, the accessibility to water is essential, which relates to water service delivery (Edokpayi et al., 2020). In relation to this, Section 27(2) of the South African Constitution states that "the State must take reasonable legislative and other measures, within its available resources, to achieve the progressive realisation of these rights" (Constitution of the Republic of South Africa, 1996; Edokpayi et al., 2020, p.190). To implement this national policy, the National Water Act (NWA) (Act 36 of 1998) was formed, as a water law that would rectify the injustices leading to unequal access and distribution of water and insufficient service delivery attributed to Apartheid laws. The NWA is recognised globally as one of the most progressive water laws in the world, with many countries borrowing from it to form their own laws (Edokpayi et al., 2020). Approved in 1998, and founded on the basic principles of equity, sustainability and efficiency, Section 2 of the NWA (Act 36 of 1998) provides guidelines for ensuring that water is equally distributed and accessed, especially by individuals who were marginalised due to past Apartheid related injustices (Karodia & Weston,

2001; Pienaar & Van der Schyff, 2007). Further, the policy aims to ensure that water is protected and utilised sustainably. This national policy advocates for citizen engagement in water management, as a necessity of ensuring citizens get equal access to water resources (Edokpayi et al., 2020). In support of this, Section 152 (1) e of the South African Constitution, states that the government should encourage communities to be involved in activities conducted by the local government. Municipal councils are also obliged to involve the community in common environmental activities according to the Municipal Act (2000) and Municipal Structures Act (1998) (Karodia & Weston, 2001).

Chapter 2 of the NWA goes on to explain two strategies which act as guidelines of how water should be managed in South Africa. The first is the National Water Resource Strategy which provides a guideline of how water resources should be used, protected and conserved. This strategy also provides a structure of how water should be managed at a regional scale within defined water management units (NWA, Act of 36 of 1998).

It therefore promotes the integrated management of water resources in South Africa, which puts the IWRM mentioned earlier into action. Also guiding water resource management are the catchment management strategies which stipulate that all sector institutions like catchment management agencies (CMAs) should create a catchment management strategy for the water resources assigned to their water management areas. These strategies must comply with the national water resource strategy and actively work to engage all interested stakeholders in water management activities to achieve integrated water resource management (NWA, Act 36 of 1998).

Additionally, this strategy advocates for citizen involvement in water resource management within the 50 water management areas as identified by the NWA. It is evident through these abovementioned strategies, that the NWA regards public participation and integrated water resource management or cooperative governance as critical principles required to achieve successful resource management (Kardia & Weston, 2001). In addition to national policies that govern water resource management, Section 24 of the South African Constitution states that "everyone has the right to an environment that is not harmful to their health or wellbeing and that the environment has to be protected for the benefit of present and future generations through reasonable legislative and other measures" (Pienaar & Schyff, 2007, p. 185). This measure aims to reduce environmental issues such as pollution and land degradation and increase conservation while ensuring sustainable use of natural resources, more specifically

water resources. Section 2 of the NWA advocates for protection of water resources, through sustainable water resource management (Pienaar & Schyff, 2007). At a more local level, the Department of Water and Sanitation (DWS) is assigned to bring into effect the NWA policy, through governing how water is accessed, used and controlled (Department of Water and Sanitation [DWS], 2019). DWS is responsible for providing local municipalities with guidelines on how water should be managed; one example of this is the Blue and Green Drop Certification programme. This programme, no longer functional, was designed to facilitate proper water and wastewater management and allows stakeholders to rate the overall functioning of water and waste treatment plants, using a specific criterion. Additionally, the programme allowed stakeholders working within the water sector to identify and report any water treatment plants that require maintenance or repair (Edokpayi et al., 2020). Despite the efforts made by policy to improve water resource management, South Africa is still faced with the challenge of mismanagement of already scarce water resources (Madigele, 2017).

South Africa's democratic legal and political laws are founded on social inclusion and active public participation (Karodia & Weston, 2001), which is necessary to achieve sustainable water resource management and the importance of water accessibility for all (Edokpayi et al., 2020). A more recent water policy which advocates for a multi-stakeholder approach to water quality management in South Africa, is the Integrated Water Quality Management (IWQM) policy. The IWQM policy and strategy was developed as a response to the ever-increasing water quality challenges in South Africa, which are not being mitigated by the existing water policies, primarily using a top-down approach to managing water resources and are failing to put this policy into practice. This is evident in the water quality and decisions pertaining to water quality managed and monitored at a national level. This type of approach often overlooks the role of communities in stewarding and ensuring that water quality is managed proactively.

An important aspect of IWQM is the inclusion of the community groups or organisations in water quality management and decisions (Boyd et al., 2011). Boyd et al (2011) also highlighted that current South African water management frameworks are focused on managing water resources at a national level, rather than managing water quality at a local level, which works against the goal of achieving sustainable access of clean drinking water for all citizens. Further, DWS (2017) notes that current water policies, have not been able to respond to the current water quality crisis over the years due to limited capacity and resources to put the policy into practice. Unfortunately, water quality challenges continue to compound due factors such as rapid economic and population growth. This has increased the need for a more integrated

approach for water quality management to support the already existing water policies. This policy emphasises that all water users should respond and manage water quality; this includes businesses, civil society, and the public sector.

Taking all this into account, and South Africa being categorised as a water scarce country globally, with less than 1700m^3 per capita of freshwater available, there is an urgent need to improve water management and use. While most of the water management responsibilities lie with the government, community participation is needed to meet the resource limitations faced by the government, and to align with the democratic imperatives discussed above (Nare et al., 2011). Citizen science projects, particularly CBWQM projects, have emerged as a potential response and solution to poor water resource management and they rely primarily on public participation.

2.4 Community Based Monitoring/Community Based Water Quality Management

As introduced in Chapter 1, Community-Based Monitoring (CBM) is a practice in which a diverse range of interested and concerned actors from varying areas of expertise, ranging from municipal and national government structures, private sector such as academic institutions, community based organisations and public citizens, collaborate in an effort to monitor and address a commonly shared concern (Bernedo Del Carpo et al., 2020; Buckland-Nicks et al., 2016; Carlson & Cohen, 2018; Conrad & Daoust, 2008; Pollock & Whitelaw, 2005). The practice is recognised as a community-led approach to collecting and analysing relevant data, often related to citizen science which is aimed at addressing the shared concern (Carlson & Cohen, 2018). Community Based Water Quality Monitoring (CBWQM) is a form of CBM, which focuses primarily on monitoring water quality, using citizen science tools (Graham & Taylor, 2018), therefore the literature presented in this chapter on CBM, will refer to the practice of CBWQM as well. One way in which the local government and environmental non-profit organisations are increasing public participation in water quality management and monitoring is through what is known as community-based water quality management (CBWQM) (Lotz-Sisitka et al., 2021). The focus of CBWQM is usually context specific and focuses on addressing an environmental concern shared in that community. CBWQM programmes have made use of citizen science approaches and tools to enable public participation to monitor water quality. The majority of CBWQM projects in South Africa have a certain degree of citizen science involvement (Lotz-Sistika et al., 2018).

CBM allows for varied levels of engagement of the general public and varying degrees of involvement with other institutions such as universities, governments, and industries (Carlson & Cohen, 2018). There is no one correct methodology of CBM that guarantees success. Rather, there are various approaches as identified by Pollock and Whitelaw (2005) and Carlson and Cohen (2018) namely, government driven, interpretive, advocacy and multi-party monitoring. Government-driven monitoring also referred to as a top-down approach to monitoring, refers to CBM projects which are introduced by government and are aimed at informing national or global objectives and policy. Government-driven monitoring often involves monitoring the trends of ecosystems. Interpretive monitoring is aimed at developing scientific literacy within citizens while educating and raising awareness within them of their environment (Carlson & Cohen, 2018). Advocacy monitoring is often initiated by citizen concern regarding a particular environmental problem, with the aim of potentially activating action-led processes that can influence policy and decision-making. Multi-party monitoring is a focus in this study, and has gained popularity over the years. This type of CBM allows for collaboration of a diverse range of stakeholders and affords citizens more opportunity in decision-making, when compared to the other approaches. This type of monitoring involves a collaboration of a diverse range of interested stakeholders who work together to address a commonly shared challenge (Carlson & Cohen, 2018; Conrad & Daoust, 2008; Pollock & Whitelaw, 2005).

Over the years, CBM has become popular, in countries such as North America, Europe, Canada, New Zealand, Vietnam and South Africa. According to Carlson and Cohen (2018), the growth of this field can be attributed to a variety of factors, such as limited levels of research in various science fields by scientists working in government and universities which is also exacerbated by minimal capacity for research. An additional push factor is the rising concern of the general public of the health and state of their environment attributed to mismanagement of natural resources by local governance. Another contributor to the popularity of CBM is the rise of simple and affordable resources and tools such as citizen science tools, that allow for collection and analysis of large environmental datasets by citizens and thus allow for accurate monitoring of water quality (Carlson & Cohen, 2018).

The benefits of CBM include an allowance for increased capacity and large sets of environmental data to be collected which contribute to solving complex and wicked environmental problems. Further, CBM promotes and strengthens community participation in natural resource management and protection, which is empowering (Carlson & Cohen, 2018; Conrad & Daoust, 2008; Pollock & Whitelaw, 2005). In terms of CBM, Pollock and Whitelaw

(2005) and Wilson (2018) have noted the impact and importance of indigenous knowledge in local communities. Indigenous knowledge is an often unexplored approach to addressing water resource management within scientific research, and could potentially have untapped potential for addressing environmental issues; therefore it needs to be explored.

As the field of CBM grows, there is a growing need to identify the factors that enable and constrain this practice often related to environmental monitoring. Identifying these factors can help with finding ways to better support the practice and ensure more public participation (Carlson & Cohen, 2018). This directly links to the aim of this research study, which is to identify the support required for scaling of social learning in CBWQM communities of practice. Despite there being numerous reasons for public involvement in CBM, there are three main reasons highlighted by Carlson and Cohen (2018) as enablers of CBM. Closely linked to citizen science, participant involvement in CBM can be driven by the public interest in developing or improving their scientific literacy and advance scientific research, referred to as interpretive monitoring (Carlson & Cohen, 2018; Pollock & Whitelaw, 2005). Interpretive monitoring empowers citizens through giving them knowledge, skills, tools and resources which helps them gain understanding of their local environment. Citizens can also engage in CBM as a response to poor governance of natural resources such as poor maintenance of water infrastructure. Lastly, participant involvement in CBM can contribute to scientific research goals that need to be met which requires large amounts of data that can only be collected through CBM. This type of CBM is often government-led, and informs decision-making and policy with the data also being used within academic research (Carlson & Cohen, 2018).

Interestingly, participant involvement in CBM can also be motivated and influenced by socio-economic conditions, which is evident when comparing the drivers of enactment of CBM in developed and developing countries. For developing countries, participants may engage in CBM as an effort to raise awareness and improve local governance of water resources, which are often the source of their livelihoods. An example of this, as shared by Carlson and Cohen (2018), are rural farmers in Ethopia, Nepal and Peru, who primarily rely on water resources for the sustenance of their farms, thus their livelihoods. In high income countries, participation in CBM often occurs as a form of recreation through volunteerism. This differs distinctly from lower income regions, who rely on the preservation of their environment for their livelihood. Although this perspective may not be the key reason for participant involvement in CBM, consideration of socio-economic backgrounds can provide an understanding of how participant involvement differs in developing and developed countries and the driving factors for each

(Carlson & Cohen, 2018). This is important to understand as this study investigates how CBM is occurring within a developing country (South Africa), in two case studies located in South Africa. To better support participant involvement in CBM, it is important to note the factors that drive it, particularly within the context in which the practice needs better support.

Interestingly, Lotz-Sistika et al. (2022) noted how participant involvement also depends on the type of CBWQM project, which all have different objectives as mentioned earlier. Carlson and Cohen (2018) highlighted that participant involvement in CBM projects is also dependent on the institutions that drive the project. Within government-driven CBM projects which refers to projects initiated by external parties and run by communities, citizens often assume the data collection role and have little to no contribution to data analysis and decision-making which eventually informs policy (Bernedo Del Carpio et al., 2020). This is contrary to community-driven projects, also referred to as locally-led approaches to CBM projects, which give citizens more agency and power regarding data collection, analysis and decision making. The degree of involvement of communities in CBM largely influences how results are used from the projects and are incorporated into policy (Carlson & Cohen, 2018). Community-led CBM projects are often regarded as more affordable and have more potential to influence local decision-making while empowering communities through raising educational awareness of their environment. While these benefits are an important outcome of CBM, the biggest challenge faced by community-led CBM projects, has been identified as short-term funding, lack of capacity and resources to manage the large amounts of citizen data (Carlson & Cohen, 2018). For government-led CBM projects, funding is likely to be more sustainable and long-term with capacity and resources to manage and analyse large amounts of data. The benefit of government-led CBM projects is its ability to influence high level policy and decision-making (Carlson & Cohen, 2018). Therefore, it is important for a CBM project to be well suited to the objectives and needs of the community in which it is implemented to ensure that project goals are realised. Ultimately, CBM projects need to be designed to ensure full community involvement and address the environmental challenges being tackled (Carlson & Cohen, 2018).

Unfortunately, over the years, scientists have lacked confidence in the ability of citizen scientists to collect and analyse data in a credible and rigorous manner. This is a challenging barrier for the CBM practice as there has been resistance from academic and governance institutions to use the data collected from it. This is due to the poor quality of data, as a result of unstandardised methods for collection of citizen science data (Pollock & Whitelaw, 2005). Although it can be argued by scientists that CBM is inappropriate to use in different fields of

science, it has interestingly been widely used within the environmental field to monitor environmental factors (Carlson & Cohen, 2018). Further, literature suggests that scientific data also lacks accuracy at times as it is open to human interpretation, which can lead to human bias. Today, the advancement of innovative technologies has simplified and made the data collection and analysis process through citizen science within CBM faster and credible enough to meet scientific standards (Carlson & Cohen, 2018; Newman et al., 2012). This process can further be supported through more sustainable funding mechanisms of CBM projects and additional capacity to manage and analyse the large sets of data produced by CBM (Carlson & Cohen, 2018).

Given that citizen science data informs policy, it is vital that CBM projects are carefully and rigorously carried out to ensure credible data collection and analysis. This can be achieved through the sharing of rigorous and scientifically approved guidelines by scientists on the data collection and analysis process applied within citizen science. This can significantly improve the quality of data collected while reducing errors and bias (Carlson & Cohen, 2018). This finding suggests that there is the lack of understanding of the needs of participants in CBM often referred to as citizen scientists, as pertaining to what contributes to poor quality data collection by citizens (Carlson & Cohen, 2018).

Different elements characterise and form the basis of CBM projects, one of the most important being collaboration and partnership. When there is a common objective between different stakeholders, who have a commonly shared concern, there is potential for collaboration. This means there is potential for both community and external needs to be met. The collaboration of different actors within CBM, and network building can provide financial and technical support to upscale CBM projects that could not be achieved in isolated CBM projects (Carlson & Cohen, 2018). Whitelock and Pollock (2005) have highlighted that partnerships can be formed with a variety of stakeholders such as municipal, governmental structures and private sectors, such as environmental non-profit organisations (NPOs), industries, Community Based Organisations (CBOs) and academic institutions such as universities and schools. The type of partnership which is needed for a CBM project, is dependent on the scale and type of project, as well as the needs being met. For CBM projects to influence national policy, there needs to be collaboration with the necessary governance structures (Pollock & Whitelaw, 2005). Although these partnerships do not automatically guarantee the improvement of environmental issues faced in a particular community, they do contribute to ensuring that accurate

environmental data is collected which influences governmental policy and frameworks (Carlson & Cohen, 2018).

To better understand how CBM is operating globally, several studies investigate how CBM is occurring in Canada, and what support it required to upscale it (Conrad & Daoust, 2008; Carlson & Cohen, 2018; Pollock & Whitelaw, 2005). CBM has grown globally and particularly in Canada, with over 200 CBM projects in operation. In Canada, this approach has become a crucial element of how water is managed, due to the failing role of local government in monitoring water-related monitoring activities (Conrad & Daoust, 2008). This has led to a rise in concern in the public and non-governmental organisations (NGOs) regarding government's ability to manage and monitor environmental resources. This is attributed to the poor prioritisation of finances pertaining to maintaining water infrastructure and managing water resources. The public has since taken up the role of government in responding to environmental issues. Case studies in Canada can therefore help with understanding how CBM is supported and is operating globally, and with considering this practice can be further supported.

To understand the factors that enable or constrain how CBM projects operate at a global scale, a survey was conducted with 270 participants within Canada. The study was aimed at addressing these three research questions; at what level the objectives of the CBM projects were being met, how CBM monitoring occurred, and the procedures followed, and how much the participants felt that the citizen science data they collected informed policy and decision making (Carlson & Cohen, 2018). The study found that five reasons that contributed to CBM projects being started, the first being attributed to a shared environmental concern of interested stakeholders. Secondly, CBM projects were initiated as a learning pathway for citizens to gain and improve their scientific literacy while learning about the environment. CBM was also initiated to supplement data gaps and increase local knowledge within scientific research. In addition, CBM influences and informs policy and decision-making, at both the local and national level. Lastly, the study found that CBM projects were initiated to address and meet scientific research goals, often driven by academic institutions or government led CBM projects. These factors are critical to note as they become the main factors that influence the type of partners CBM projects collaborate with to meet their goals (Carlson & Cohen, 2018).

Interestingly, the study also revealed that CBM projects that had community and government support were more likely to achieve their project objectives, in comparison to CBM projects that only rely on one type of partner. Additionally, government support, resulted in increased

capacity and resources, necessary for data management within CBM. However, the study found that there was no direct correlation between the types of government structures or partners that supported a CBM project, and its success (Carlson & Cohen, 2018). In light of this, it is evident that more work needs to be done by government to support CBM projects, as these projects often directly meet government objectives of providing necessary data to respond to complex environmental issues. Further, CBM projects support and often fulfil the failed role of government in addressing water-related issues in many communities (Carlson & Cohen, 2018). It is for this reason, that more support in the form resources and capacity needs to be provided for CBM projects.

To further understand CBM in Canada, a study was also conducted by Pollock and Whitelaw (2005), in which a conceptual framework was designed to guide the implementation of CBM projects in 31 communities. Evaluating the framework, the study found that it was important for CBM projects to be designed to be context specific to the needs of the community. Based on this limitation, a revised conceptual framework was developed, which suggests that the following factors be incorporated when designing and implementing CBM projects (Pollock & Whitelaw, 2005). Firstly, the study found that CBM projects should be context-specific, which means they should meet the needs of their local community and address local environmental challenges. Secondly, the conceptual framework should be iterative, meaning CBM activities must be adaptable to changing circumstances and allow for constant refinement, so as to ensure capacitation of involved stakeholders more effectively. Lastly, the conceptual framework must be adaptive, so as to ensure meeting the changing environmental needs of natural resource management. The revised conceptual framework also highlighted four themes that are important to consider when designing and implementing CBM projects. These are mapping, information delivery, participation assessment and capacity building. In this study, I focus on capacity building, which is a potential scaling pathway for CBWQM which my study seeks to explore (Pollock & Whitelaw, 2005). According to Pollock and Whitelaw (2005), capacity building for CBM projects is increased by a number of factors. One of these is through collaboration with private and public sector stakeholders. Through collaboration with more influential stakeholders such as provincial and national governance structures, CBM projects are more likely to get exposure, which in turn attracts potential funding and resources. For more local collaborations, such as with municipal authorities, the strong networks that are built amongst stakeholders increase interest in the community members in their environment. According to Pollock and Whitelaw (2005), CBM partners can range from “municipal,

provincial and federal government agencies, environmental organizations, industry representatives, community groups, academic institutions (from elementary to post-secondary), conservation areas, field naturalists, parks, and biosphere reserves, to name a few (pp. 221-222).

With the growing environmental issues induced by anthropogenic activities, it is evident that more data-driven forms of interventions need to be implemented to address these complex environmental issues (Danielsen et al., 2020). The collaboration of scientists and citizens in generating environmental data can help inform environmental decision-making and address environmental issues. This study looks at an array of literature on environmental monitoring to assess whether public participation in environmental monitoring influences the rate of decision-making which leads to environmental decision-making (Carlson & Cohen, 2018). The study distinguishes between two levels of public participation in CBM. The first role is that of the citizen only collecting data, and the second is the of the citizen being responsible for collecting and analysing the data. It is important to distinguish between these two types of monitoring to understand the effects on the participant involvement and achievement of CBM project objectives.

Danielsen et al. (2020) highlighted that CBM projects that have less public participation and more scientist (academic) involvement, are more likely to inform policy and decision-making, rather than meeting community needs. CBM projects that are largely driven by citizens are likely to have outcomes that influence local policy and decision-making, which also means they are likely to be implemented more quickly. This finding supports the findings by Carlson and Cohen (2018) regarding the scale and level of influence different types of CBM projects in decision-making. This is a critical component of understanding the level of policy engagement community-led CBM/CBWQM projects in influencing policy linked to Scaling Pathway 1. This further emphasises Carlson and Cohen's (2018) suggestion to design CBM projects which address the needs of the issues faced in a specific community. Participation of citizens in environmental monitoring can build a sense of ownership and stewardship for their environment, which is an essential component of changing the way humans interact with the environment to contribute to its preservation (Graham & Taylor, 2018).

2.4.1 Community Based Water Quality Management: A review of progress so far in South Africa

According to Graham and Taylor (2018), South Africa faces significant water quality challenges which are attributed to harmful anthropogenic activities on the environment. “In South Africa, over 80% of our rivers are in such a bad state that they have been classified as threatened. Of these, 44% are critically threatened.” (Graham & Taylor, 2018, p. 1). As a response to this water crisis, substantial efforts to research the potential of citizen science to effect meaningful change in water resource management have been made. This is in response to the low levels of capacity of water authorities in South Africa to monitor, manage and address the worsening and continuing water quality challenges we face. Additionally, there is a palpable division regarding water resource management and use amongst different parties, such as NGOs, civil society, and government institutions (Graham & Taylor, 2018). This lessens the opportunity of addressing these water quality issues in a collaborative manner. This is where Community Based Water Quality Management (CBWQM) plays a role, as a response to poor local governance and water quality challenges using citizen science.

This is attributed to the assumption that if citizens are more knowledgeable of the quality of their water resources and the factors that threaten them, there is significant potential for working with government structures to manage their water resources in an effective manner (Graham & Taylor, 2018). Furthermore, the understanding of water quality and its management empowers citizens to engage in action-led processes in advocating for improved water quality, rather than surface-level activities such as protesting. It is evident that the water quality issue in South Africa requires an urgent response which is people-centred (Graham & Taylor, 2018). There has been considerable effort by policy at all levels to increase public participation in water resource management as mentioned earlier. To understand the level of impact of this legislation on South Africa; it is useful to observe what is happening on the ground.

To understand how CBWQM projects are operating in South Africa, a review was conducted by Lotz-Sisitka et al. (2022). The aim of the evaluative review was to identify existing CBWQM projects in South Africa, in an effort to identify the factors enabling or constraining the success of these projects, to contribute to the development and capacity building of new or existing CBWQM projects in South Africa. The first phase of the study included an analysis of questionnaire data completed on the Question-based CBWQM review tool by CBWQM group participants. Overall the online review captured information of a total of 31 CBWQM projects, with 22 (71%) of them still operating and 9 (29%) recorded as inactive. This initial

analysis process provided a snapshot summary of the potential areas that required further analysis to support CBWQM projects in South Africa. The initial analysis singled out the following factors as emergent themes from the online review data; namely policy engagement, partnership structures, involvement of citizens, what projects on the ground do, innovations, learning and capacity building, enablement and constraints and expanding projects. These factors from the initial analysis informed the development of an analytical framework (see Figure 1.1) used as a tool in the study for deeper analysis of seven CBM projects selected from the 10 in the initial analysis. The seven case studies were selected as best practice examples of CBWQM projects due to their diversity in terms of the types of partnerships, government support and structure, which was a clear representation of the diversity of CBWQM projects in South Africa. As indicated in Chapter 1, this study forms part of this broader Water Research Commission (WRC) project, and the analysis focused mainly on Scaling Pathway 1 (Political Economy and Policy Support) and Scaling Pathway 3 (Capacity Development), explained later in this chapter.

A major finding from the national review (Lotz-Sisitka et al., 2022) was that the majority of the CBWQM case projects had a diverse range of stakeholder partnerships, which include private (local businesses) and public sector (local municipalities and civil society) who support public participation in CBWQM work. Due to the diversity of the partnerships for each project, the level of government support varied for each CBWQM project depending on the scale and scope of the project. For example, national CBWQM projects or initiatives attracted support from national government, while other projects such as Msunduzi DUCT River Sewer Line Discharge and General River Pollution Monitoring and Maintenance (MSU) project received support from local government (Lotz-Sisitka et al., 2022). An example of a project that has received national government support is the Adopt-a-River project, which was initiated at a parliament level in 2006, to raise awareness, create a sense of ownership and increase public participation by South African citizens in caring for their local water resources, specifically their rivers. Furthermore, this project was aimed at gaining commitment from governmental authorities in managing and conserving their water resources. This project was implemented through DWA (Department of Water Affairs) at national government level, who supported the volunteer-based programme (Lotz-Sisitka et al., 2022).

The MSU project is an example of a CBWQM project that received local government (Msunduzi Municipality) and civil society (Duzi uMngeni Conservation Trust – DUCT) support. Initiated as a response to poor water and sanitation service delivery by the uMsunduzi

Municipality in the Sobantu, Ashdown and Mbali communities, the project is aimed at monitoring, reporting and managing leaking sewers and educating the public on water and sanitation (Lotz-Sisitka et al., 2022; Taylor & Cenerizio, 2018) as briefly introduced in Chapter 1. The project was supported through funding and resources by the Msunduzi Municipality with DUCT as an implementer (Taylor & Cenerizio, 2018). The study by Lotz-Sisitka et al. (2022) also found that for local CBWQM projects, government support is often minimal to none (Lotz-Sisitka et al., 2022). In uncommon cases, some CBWQM projects are supported by broader structures which coordinated and convened cohesive water management with a range of powerful stakeholders at a regional level (Lotz-Sisitka et al., 2022). An example of this is the Amanzi Ethu Nobuntu (AEN) programme introduced in Chapter 1, which was supported through national funding from the Department of Science and Innovation (DSI). Understanding how partnership structures enable or constrain the scaling of CBWQM projects is important in order to better support them in South Africa.

The level of citizen involvement in CBWQM projects was also noted as a potential factor that required further research and which was earmarked as a scaling mechanism and pathway. Each CBWQM project had a different level of citizen involvement with the most common forms of citizen involvement (CBWQM participation) ranging from Enviro Champs,[2] volunteerism and employment of citizens through monthly stipends by community works programme. In instances where CBWQM participants work as volunteers often within academically and NPO-led, supported and coordinated CBWQM initiatives, funding is often unsustainable as it is largely dependent on the partnerships with these institutions. The downfall of this type of citizen involvement is its reliance on funding which is often unsustainable and continues to be a challenge for CBWQM work. As mentioned in Chapter 1, one of the biggest threats to the CBWQM practice is inconsistent funding, which affects all levels of participant involvement in CBWQM projects (Lot-Sisitka et al., 2022).

Further to the abovementioned finding, careful consideration regarding citizen involvement and upskilling of citizens to partake in CBWQM projects needs to be made. A lack of clarity in CBWQM participants' roles can lead to unmet expectations in terms of what citizens hope to gain from the project and the level of impact the citizen science data they have collected will have in local decision-making and policies. According to Lotz-Sisitka et al. (2022), if this

[2] Enviro Champs refers to environmental champions who are responsible for championing environmental health through raising awareness and educating the public on the environmental related issues (Ward, 2016).

information is not communicated effectively and CBWQM participants are inadequately skilled, supported and resourced to conduct CBWQM activities, this can reflect badly on community groups partaking in citizen science projects, and produce erroneous data (Lotz-Sisitka et al., 2022). Prior research by Haklay et al. (2021) emphasises how individuals get involved in citizen science projects out of interest in science (to gain scientific literacy) and eagerness to learn which speaks to the expectations of participants in CBWQM projects as alluded to by Lotz-Sisitka et al. (2022). This is ultimately the objective of citizen science, which is to improve scientific literacy of the public, increase public participation in scientific research and develop advocacy within individuals, particularly in water resource management to collaborate with governance structures to manage water resources in an effective and sustainable manner (Graham & Taylor, 2018; Lepczyk, 2020; Haklay et al., 2021).

Pertaining to the abovementioned findings on citizen involvement in CBWQM projects, a study conducted by Weingart and Meyer (2021) on 56 citizen science projects in South Africa found that majority of individuals who participated in the projects contributed through data collection only and were not involved in any other capacity beyond that. Additionally, minimal effort was made by structures who coordinated and funded these projects (which was a joint effort between academic, government, and NPO institutions), to engage participants in policy discussions and decision-making using the project outputs. In addition, the study found that majority of citizen science projects were aimed at meeting scientific goals and were less focused on educating the general public on the science behind the practice of citizen science. These findings substantiate claims made by Lotz-Sisitka et al. (2022) in the review of CBWQM projects, which emphasises that conscious effort should be made when considering public involvement in citizen science initiatives. This should be done in an effort to meet the expectations of the participants, which should ultimately be to educate the citizens and enhance their individual capability in responding to commonly shared environmental challenges (Vann-Sander et al., 2016).

The Lotz-Sisitka et al. (2022) review also noted that there was direct policy engagement by CBWQM projects at all levels, which included local, provincial, national, and international. These projects engaged in CBWQM activities through monitoring and management activities such as monitoring of leaking manholes, water leaks and illegal dumping sites. This information was also shared to engage the public and local municipal authority to respond to environmental issues, of which a critical component of policy engagement is holding

responsible authorities accountable for water resource management. CBWQM projects also created platforms of engagement and raising educational awareness of water quality with the public through activities such as door-to-door education, clean-up campaigns and events. These social activities educated and raised awareness of some of the environmental challenges faced within communities (Lotz-Sisitka et al., 2022). Digital citizen science apps such as GeoODK[3] (Geographical Object Driven Knowledge) which captured spatial, geographical and descriptive data played a pivotal role in monitoring and storing of water quality information by Enviro Champs which was used to communicate water quality information to relevant authorities (Lotz-Sisitka et al., 2022).

Another area identified from the review which required further analysis is the innovation component within CBWQM projects. This was identified along three dimensions, firstly through the diversification and expansion of citizen science tools using technology such as GIS and mobile apps like GEO ODK. The second innovation that was identified was the type of public engagement activities in CBWQM work, which helped form partnerships and networking structures. An example of this is the street theatre productions[4] and the trashion show.[5] The third type of innovation is the learning pathways afforded by CBWQM work for CBWQM participants. The learning pathways upskill and capacitate participants through capacity building opportunities offered through CBWQM projects which prepare CBWQM participants for entry level jobs. Examples of these learning pathways include basic plumbing, green skills development and training that can lead to NQF level educational qualifications. These three innovations are as a result of the opportunities created by CBWQM projects (Lotz-Sisitka et al., 2022).

Learning and capacity building was also highlighted as an area of further analysis from the review in CBWQM projects, which is a core focus of this study in relation to enabling scaling of CBWQM outcomes and practices. According to the findings of the national review, learning

[3] GEO ODK is a citizen science, open source mobile based app or platform, that is used to collect and share citizen science data ranging from activities such as recording the number of spilling manholes and the number of household visits (Lotz-Sisitka et al., 2022).

[4] Street theatre productions are a community engagement and awareness raising activity initiated by the Mpophomeni Enviro Champs. These plays are designed to raise awareness within the public of the water quality and environmental issues faced in the community while opening up space for dialogue relating to these topics (Ward, 2016).

[5] Trashion show refers to an Enviro Champs initiated educational activity aimed at educating kids on the importance of correct waste disposal and recycling. The Enviro Champs host a fashion show, referred to as a 'trashion show' to which they invite kids to create fashionable items to showcase using recyclable waste (Ward, 2016).

and capacity building were most effective when they occurred within a social context, that included fieldwork experience and content-based learning (Lotz-Sisitka et al., 2022). Furthermore, a social context that has a diverse range of stakeholders in which citizens can learn from each other is a vital component within learning and capacity building, particularly when supported and facilitated by those in higher authority. An additional component that was highlighted within learning and capacity building, is the importance of discussing and acquiring a good understanding of the issue that is addressed. This is to ensure that there is not misinterpretation of the issue which often occurs amongst community members (Lotz-Sisitka et al., 2022). A useful model which could potentially support and strengthen learning in this regard is the 5 Ts of Action Learning model, developed by Rob O'Donoghue (see Figure 2.1 that follows). According to Graham and Taylor (2018) and Leapheana et al. (2021), the 5Ts of Action Learning Model is a useful tool to support an actively engaging process for citizen science learning. The model is made up of five components, namely Talk, Think, Touch, Take Action and Tune-in. The five elements centre around the "the nexus matters of concern" or issue that is to be addressed, in this context poor water quality (Graham & Taylor, 2018).

The 'tuning in' component of the model, establishes the "matter of concern", which is the issue that is being addressed. This phase allows participants to engage in discussions on the issue being addressed and establish what prior knowledge they have and may need to solve the issue. The 'talk' element is a collaborative process that involves citizens and exchanging ideas through discussion of tools and information needed to resolve the identified issue (Graham & Taylor, 2018). This includes identifying areas that require further research. The 'touch' element is regarded as the most important part of the learning process, which involves allowing individuals to apply what they have learnt. In this context, citizens are given an opportunity to practically apply citizen science tools, which would enhance the learning and capacity building process. The 'think' element refers to engaging citizens in learning actively, by giving them a platform to ask questions if they require clarity during the learning process. Lastly, the 'Take Action'component refers to practical application of what has been learnt within the context of the issue being addressed. (Leapheana et al., 2021). Graham and Taylor (2018) claimed that this model is highly effective in teaching citizen science tools, which is a common focus of capacity building for many CBWQM projects in South Africa, particularly those reviewed in the project by Lotz-Sisitka et al.(2022). Lotz-Sisitka et al. (2022) supported this stating that citizen science tools were an important aspect of learning and capacity building which

supported CBWQM activities and enhanced the learning process of CBWQM participants (Lotz-Sisitka et al., 2022). Figure 2.1 below depicts the 5Ts of Action Learning Model.

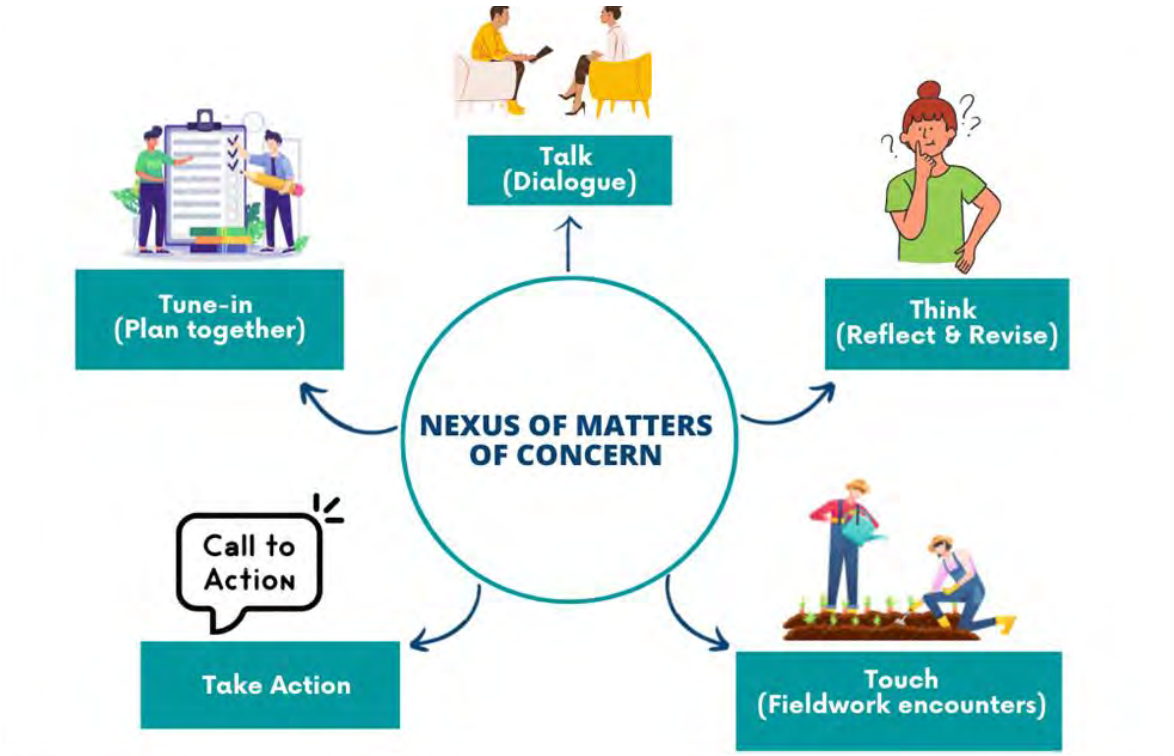


Figure 2.1: The 5Ts of Action Learning Model (Graham & Taylor, 2018)

Various constraints were highlighted by Lotz-Sisitka et al. (2022), which hindered CBWQM projects from operating effectively. One of these constraints was the level of accessibility and availability of citizen science tools and of resources to follow through with the monitoring and reporting process (this includes websites or platforms for data processing and verification) of water quality data. Due to this constraint, CBWQM participants are unable to respond to expanding CBWQM projects, that require large amounts of water quality data to be collected, processed and reported on in a rigorous manner. Vallabh et al. (2021) notes that to overcome this challenge, citizen science projects should be well planned to create trustworthy data that can be used by a variety of stakeholders such as scientists, policy makers and the general public. Hulbert et al. (2019) supported this notion, stressing the importance of capacitating citizen scientists with the skills to collect quality data, as this influences the success and sustainability of a citizen science (CS) project. Vallabh et al. (2021) further highlighted that technology advancement, and the internet has played a crucial role in upscaling the practice and process of

CBWQM activities through allowing for increased collecting, managing, analysing and sharing of copious amounts of citizen science data in a time efficient manner.

Another constraint that was noted was insufficient support offered to volunteers (those unemployed) who participated in CBWQM projects with regard to the provision of personal resources which created obstacles and affected their level of participation in the CBWQM activities. The volunteers often lacked transport, airtime and stipends to support CBWQM activities and their livelihoods. An additional prevalent issue constraining CBWQM practice was the lack of sustainable funding which was often short term or ad hoc to support CBWQM projects in the long run. This issue was exacerbated by insufficient capacity regarding project management funds and coordination, which meant that CBWQM projects were short-term with funding drying up. Poor municipal buy-in coupled with weak cooperative governance was also raised as a constraint to CBWQM projects as this caused delays in project implementation and stunted the upscaling of the practice. Related to this was the challenge of poor working relationships between CBWQM participant groups, which impacted on the progress of CBWQM projects, especially smaller community-led projects, that rely on community buy-in and relationships to succeed (Lotz-Sisitka et al., 2022). Poor capacity to implement CBWQM initiatives in different institutions such as schools and community groups was also highlighted as a challenge that constrained CBWQM projects (Lotz-Sisitka et al., 2022).

A recent was study conducted by Potts et al. (2021) on South African Marine Citizen Science (SAMCS) projects, which has become a popular form of Citizen Science in South Africa, having started in the 1930s. Potts et al. (2021) noted that historically there has been limited documentation of successful CS projects in developing countries compared to developing countries. This is not the case for South Africa, which is one of a few developing countries with a long history of operating CS projects. The study sought to review SAMCS and identify ways to scale existing SAMCS projects and motivate the development of new ones. In an effort to increase public engagement in CS in developing countries such as South Africa, the study identified three types of CS projects; it is important to be cognisant of these to gain a broader understanding of the types of CS projects active in South Africa and for considering how best to support them.

The first kind of CS project is *classical CS*, which refers to CS projects that citizens engage in collecting data as a recreational activity for the production of knowledge. These types of projects are often operating at a broad geographic scale and with a large number of observers

(citizen scientists). An example of such a project is the Audubon Christmas Bird Count (Potts et al., 2021). The second type of CS project is referred to as *environmental management CS*, which refers to CS projects that are initiated by communities as a response to commonly shared environmental issues. A prime example of such a project in South Africa is the Stream Assessment Scoring System (miniSASS) initiative, which allows citizens all over South Africa to collect and share water quality data of their rivers, in an effort to raise awareness and educate themselves on the health of their local streams (Graham et al., 2004).

From the recent abovementioned review conducted by Lotz-Sisitka et al. (2022), it is evident that environmental management CS projects have been on the rise, with the main driver – as alluded to by Carlson and Cohen (2018) and Lotz-Sisitka et al. (2022) – a commonly shared environmental concern in the community, related to failure of local government to manage, monitor and respond to water quality challenges. The third type of CS project is *citizen cyberscience* which utilises technology advancements such as websites and mobile apps to run citizen science projects. These projects are often initiated to increase public participation in natural resource management and reach scientific goals (Jennet et al., 2016; Potts et al., 2021). An example of such a project is the Mpophomeni Enviro Champs Project (Case Study 1), which utilises mobile apps such as Field Survey[6] and the GEO ODK app, to record and store water quality data. This form of cyberscience CS project that uses mobile apps to collect data is becoming increasingly popular and is sometimes referred to as participatory sensing.

Cyberscience CS projects are an important form of CS project to explore and consider when identifying ways to upscale CBWQM projects in South Africa. The majority of communities in South Africa are challenged with water quality coupled with poor service delivery issues located in rural communities and they are often marginalized. Although CS projects aim to be inclusive, rural communities in South Africa are often left out due to lacking access to citizen science tools to actively engage in CS projects. To substantiate this claim, Potts et al. (2021) argued that the lack of inclusivity in relation to citizen participation in CS projects is a major issue in South Africa, as SAMCS projects often attract participants who are of higher socio-economic status due to the costly tools required to engage in SAMCS CS activities. Potts et al. (2021) therefore urged that participation of citizens in CS projects be simplified and made accessible to all socio-economic groups. While technology offers opportunities to increase

[6] Field survey is an open source, mobile-based app that is used by Enviro Champs to collect citizen science data (Taylor & Cenerizio, 2018).

public engagement in citizen science projects for large groups, it also simultaneously can exclude some groups considering the type of tools or resources that certain CS projects may require. It is therefore imperative to note that socio-economic contexts of citizens largely impact on their involvement in CS projects (Hulbert et al., 2019). In light of this, to reiterate an earlier point made by Pollock and Whitelaw (2005), when initiating or implementing a CS project, one should consider the socio-economic landscape of the community it is being implemented in and understand the needs of citizens with regard to what skills and resources they require to actively engage in CS projects.

As alluded to by Lotz-Sisitka et al. (2022), poor access to CS tools and resources to engage in CBWQM activities for citizens is often a constraint of CBWQM projects. Furthermore, the COVID-19 pandemic has had significant impact on citizen science learning and impacted on the traditional methods of training that occurred physically, prior to the pandemic. An example of such physical training that allowed for shared capacity building and learning is the educational CBWQM activities of the Mpophomeni Enviro Champs project, which include door-to-door visits, enviro clubs[7] that engage with schools and street drama (Lotz-Sisitka et al., 2022). With capacity building earmarked as a potential scaling pathway for the practice of CBWQM as highlighted by Lotz-Sisitka et al. (2022), and it being an important component of learning for CS participants, it is useful to explore other learning platforms. Cyberscience could be an avenue to accommodate the changing landscape of CS and could increase accessibility of CS projects in marginalised communities.

There are a number of benefits identified by Potts et al. (2021) which were revealed by the review of SAMCS, applicable to the overall practice of CS and consequently CBWQM. One of these benefits is the contribution of large-scale CS projects in contributing to scientific knowledge and informing policy, as well as scientific literacy, in this instance ocean literacy. Further, SAMC projects have increased scientific literacy within the general public, through citizen engagement. The review highlights that CS projects that had a capacity building component (such as training), were a critical component that contributed to scientific literacy (Potts et al., 2021). Another insightful advantage of CS projects is their ability to bridge the gap of poor service delivery attributed to a lack of cooperative governance in water resource

[7] Enviro or eco clubs in Mpophomeni are a community (primarily school-based) education engagement tool, based on the well-recognised Eco-Schools programme of the Wildlife and Environment Society of South Africa (WESSA). The Enviro Champs engage with schools on a weekly basis through various education activities about proper management of environmental resources (Ward, 2016).

management. CS projects provide a cost-effective alternative to monitoring activities that are often time-consuming and intensive when conducted by local government as they may lack capacity (Potts et al., 2021).

Potts et al. (2021) highlighted challenges for SAMCS projects which can be generalised to CS projects, and consequently CBWQM projects in South Africa. As mentioned earlier, a common issue noted by Lotz-Sisitka et al. (2021) as a critical limitation of CS projects, is inconsistent funding which affects the sustainability of the project. This claim was supported by Hulbert et al. (2019), who flagged lack of funding as a common issue facing research projects in South Africa. The authors emphasised that although CS projects do not require large amounts of funding to be initiated, they are reliant on sustained funds to continue operating and maintain labour force (volunteers or citizen scientists) and resources that contribute to CS activities, such as websites which host and store CS datasets.

According to Potts et al. (2021), CS projects that have institutional support (in the form of NPO or government support), are able to sustain CS projects for longer. A solution to the funding issue of CBWQM projects proposed by a previous study by Lotz-Sisitka et al. (2022), and pilot tested via the Amanzi Ethu Nobantu project by DUCT, is a blended finance approach to finance CS projects and more specifically CBWQM projects/initiatives. This solution is applicable to sectors or stakeholders that share common interests, which can include fulfilling policy requirements or accessing water resources. Hulbert et al. (2019) proposed an interesting solution to this funding challenge, which was applied to the Cape Citizen Science Project, aimed at building scientific literacy in citizens and contributing to scientific knowledge. To finance this CS project, financial support was requested through crowdsourcing campaigns such as Discovering Plant Destroyers in South Africa and cooperate sponsorship. Philanthropy support is also proposed as a potential funding mechanism for CS projects, which could be explored by pooling all CS projects in South Africa together to request for philanthropic support. It is evident from these proposed potential solutions that a new and innovative approach to fund CS projects is urgently needed, and therefore more research that explores applicable and sustainable solutions to funding issues of South African CS projects is required.

Another challenge faced by CS projects is the inability to attract and retain CS participants, despite the diverse range of CS projects available for citizens to engage in. The following factors are identified as constraints to citizen engagement in CS projects: a lack of awareness of CS projects due to a limited information available that can be shared. Limited access to

technology and resources for citizens to engage in CS activities and a lack of trust and confidence in citizens of CS projects (Hulbert et al., 2019). Recent studies by Lotz-Sisitka et al. (2022) and Carlson and Cohen (2018) have emphasised that these constraints are also true for CBWQM projects as well. An interesting finding from the review, which can contribute to participant retention in CS projects, is the importance of reporting back to participants the value and use of the citizen science data they have collected. CS participants appreciate open communication of the contribution of the work they are doing. This type of constant interaction between participants and scientists, which digital communication platforms such as social media support, helps to build a sense of trust and belonging for citizen scientists, which can positively influence participation and retention of citizens in CS projects (Potts et al., 2021). Hulbert et al. (2019) noted that due to the diversity of communities in South Africa, an array of CS projects are able to coexist, which can also lead to redundancy of projects. The authors suggested that in instances where the same type of CS project exists within the same community, working together and sharing tools, resources and information can maximise CS work. This notion is important and should be considered in the case of rural South African communities, and more particularly for CBWQM projects which address the same issue of water quality, often in the same community or catchment.

CBWQM is a type of CS project that shares many similarities to the abovementioned examples of CS projects in South Africa. Gaining an understanding of how CS projects are operating is a useful lens to observe how CBWQM projects are operating on the ground as the enablement and constraints faced by CS projects, are subsequently faced by CBWQM projects. The biggest commonality for CS projects in general and CBWQM projects in particular, is that both these types of projects are aimed at solving a commonly shared issue within a particular community through citizen involvement. This review therefore provides a nuanced overview of the landscape of CS projects, and subsequently CBWQM projects in South Africa. A key characteristic of CS projects is not the level of citizen or professional scientist involvement in a project but is rather the active engagement of the public in scientific research (Miller-Rushing et al., 2012).

2.4.2 Role of citizen science in CBWQM

Citizen science is a fundamental component of CBWQM, as it is a practice that fosters public participation in scientific research, particularly within the environmental field through citizen

science (Haklay et al., 2021). To enable scaling of CBWQM outcomes and practices, we need to understand what citizen science is and how it can be supported to enable CBWQM work. The earliest research and publications of citizen science are found in the United Kingdom (UK), due to citizen science being an English concept. Coined by Alan Irwin, the term was added to the Oxford Education Dictionary (OED) in 2014 (Eitzel et al., 2017). Irwin defined citizen science utilising two notions: the first, that citizen science was regarded as the duty that science should contribute to society, which can be referred to as the democratisation of science. The second notion was that citizen science engaged citizens in scientific research through observation or data collection (Eitzel et al., 2017). Although this definition emphasises the joint effort of scientists and citizens to resolve scientific inquiry, the definition is limited because it does not sufficiently encompass the activities that citizen science is associated with (Eitzel et al., 2017). Historically, the term 'citizen science' caused confusion within the scientific community due to its varied interpretations (Vallabh et al., 2021). However, presently, the practice has contributed to helping us understand the world and has increased citizen participation in scientific research (Lepczyk et al., 2020). Miller-Rushing et al. (2012) pointed out that citizen science is not a novel practice; it has existed for years, with citizens practicing it through observing and recording interactions of their natural environment in an effort to address research questions. These observations have contributed to scientific knowledge and yielded large datasets that have contributed to the field of ecology.

Citizen science is a broad term with a variety of definitions and it takes different meanings depending on individual's backgrounds and experiences. Also referred to as crowd, networked, participatory or community science, a series of authors have defined citizen science as citizen involvement in collecting and analysing scientific data (Bonney et al., 2009; Cunha et al., 2017; Eitzel et al., 2017; Hulbert et al., 2019; Jollymore et al., 2017; Potts et al., 2021; Roy et al., 2012). A recent definition by Vallabh et al. (2021) has expanded on this by defining citizen science as an effective tool to provide for public policy and management needs, particularly in developing countries. Although this field has existed for years, there has been increasing recognition and interest in the field within science, education and policy sectors. Citizen science has been acknowledged as a viable option for conducting research due to its ability to provide a potential learning pathway for citizens to improve their scientific literacy. When citizens engage in CS projects their interest grows in the field of science and comprehension of the CS project in which they are engaged. Citizen science is a powerful tool to educate the public, increase public engagement in scientific research and develop environmental advocacy

in citizens (Haklay et al., 2021). Furthermore, citizen science has the potential to unite and strengthen scientific evidence with policymaking and increase social innovation, social activism, and, most importantly, individual capability (Haklay et al., 2021). Citizen science is a particularly powerful tool within environmental management, as it is able to produce large data sets that are required to solve large-scale complex environmental problems (Cunha et al., 2017; Overdevest and Stepenuck, 2004). Lepczyk et al. (2020) cautioned organisations, governmental agencies and higher education institutions who initiate CS projects to not regard public involvement in CS projects as an avenue for simply conducting low-cost research. Instead, CS should be regarded as an opportunity for citizens to contribute to scientific knowledge and develop their scientific literacy.

Literature demonstrates that citizens engage in citizen science through a variety of ways, not only through contributing to research. In the past, the majority of citizens have only contributed to citizen science through collecting data as observers and reporters. Today, citizens often contribute to citizen science projects in a more in-depth process through involvement in analysis of the collected CS data. Tweedle et al. (2012) classified CS projects into three broad categories, namely, contributing, collaborative and co-created projects. Contributing projects involve citizens through the data collection process and are most often designed by scientists for scientific research. Collaborative projects are also designed by scientists but are unique in that they involve citizens in more than one phase of the data collection process. This can include analysis of the CS data or involvement in the decision-making process after data analysis. Co-created projects are designed through collaboration of scientists and the community, with citizens being able to engage in all stages of the research process (Tweedle et al., 2012). CBWQM can be categorised as a collaborative project, as it allows citizens to be involved in multiple phases of the research process; involvement is not limited to data collection. An interesting insight by Lotz-Sisitka et al. (2022) related to CBWQM, is that engagement in citizen science projects through community-based water quality monitoring also enables social learning which facilitates knowledge to be shared at different levels, thus achieving educational and environmental awareness goals.

2.4.3 Social learning and CBWQM

Social learning has become an increasingly popular concept in literature, but there seems to be confusion and varied views on its meaning. The varied definitions of social learning by researchers have made it difficult for it to be understood and applied in socio-ecological

environments. According to Reed et al. (2010), there are key ways in which social learning has been misinterpreted in literature; firstly social learning is often confused with enabling factors that allow social learning to occur, such as stakeholder participation. Although stakeholder participation enables and supports social learning one cannot assume that social learning is taking place in an environment because of it. Secondly social learning is often defined according to its potential outcomes. For example, social learning in the environmental sector is usually related with pro-environmental behaviour, where an individual's actions have minimal effect on the environment, with writers such as Pahl-Wostl et al. (2008) referring to social learning as "sustainable learning". Although social learning may lead to outcomes such as pro-environmental behaviour, it does not necessarily mean that social learning has taken place. Change in behaviour can be an outcome of different learning processes other than social learning. Thirdly, there is little differentiation made between individual and wider social learning within literature. According to Reed et al. (2010), learning occurs in an individual then diffuses into the wider environment as a result of social interaction. The change in behaviour seen in an individual's actions, is usually influenced by their environment. The poor clarity in defining social learning has made it difficult for one to understand social learning and recognise if it has taken place, and if it has, to what extent.

According to Reed et al. (2010), in order for learning to be regarded as social learning, it must exhibit three of the following traits. Learning must portray a change in one's behaviour, this can be change that has occurred at a surface or deep (internal) level. Secondly, the change in behaviour of the individual (this includes learned ideas and behaviours) can diffuse to the wider society in which the individual belongs. Finally, learning must occur through interaction within a social network. Therefore, social learning can be defined as a process that results in changed behaviour in an individual, which extends to wider society through constant interactions within small groups.

Wals et al. (2009) argued that all learning is underpinned by social interactions (that is, interacting with oneself, your environment and society). These interactions influence one's behaviour and attitude, resulting in the unlearning of some behaviours and the strengthening of other learned behaviour. Although this inter-relational component of learning is heavily emphasised within social learning, it is not the distinguishing factor that differentiates social learning from other forms of learning especially as used in the environmental sector. Complex issues such as sustainability and natural resource management problems require more than one approach. A large part of what defines social learning in the environmental sector emphasises

the need to incorporate multiple ideas and ways of thinking in order to develop solutions that address complex environmental issues. This key component of social learning is referred to as a diverse stakeholder group (Wals et al., 2009). This diversity creates an environment for new innovative ideas and solutions to challenging environmental issues such as sustainability. But this process cannot occur without social cohesion. Social cohesion enables connections to be formed between stakeholders and allows for ease of communication, which is a critical part of social learning often emphasised within literature. Another aspect that enables social learning is the ability to create an environment that enables social cohesion to occur effectively. This environment allows stakeholders with different values and ideas to coexist and engage on a common task, which leads to an understanding of different perspectives and innovative solutions (Wals et al., 2009).

According to the articles surveyed by Rodela et al. (2012) in a (Re)views of Social Learning Literature monograph, 74% of the literature reviewed stated that social learning is enabled by constant engagement and interaction between diverse stakeholders in long discussions to find solutions to common problems. This constant engagement allows for social learning to occur. Lotz-Sisitka (2012) has argued that this typology is not entirely true as not all stakeholders involved in a deliberation are trained on sharing their views and engaging in a deliberation. Therefore, it cannot be assumed that deliberative processes will lead to shared understanding on a common issue or a learning outcome. Other factors can influence the learning environment such as time constraints, power struggles and fluctuations in attendance. Therefore, more work needs to be done to prove that deliberative processes actually lead to social learning. The diverse stakeholder groups involved in the CBWQM groups described in the case studies above therefore provide an important opportunity to further study deliberative and social learning processes, both to develop the social learning theory further, and to enhance the practice of and build scaling pathways for CBWQM.

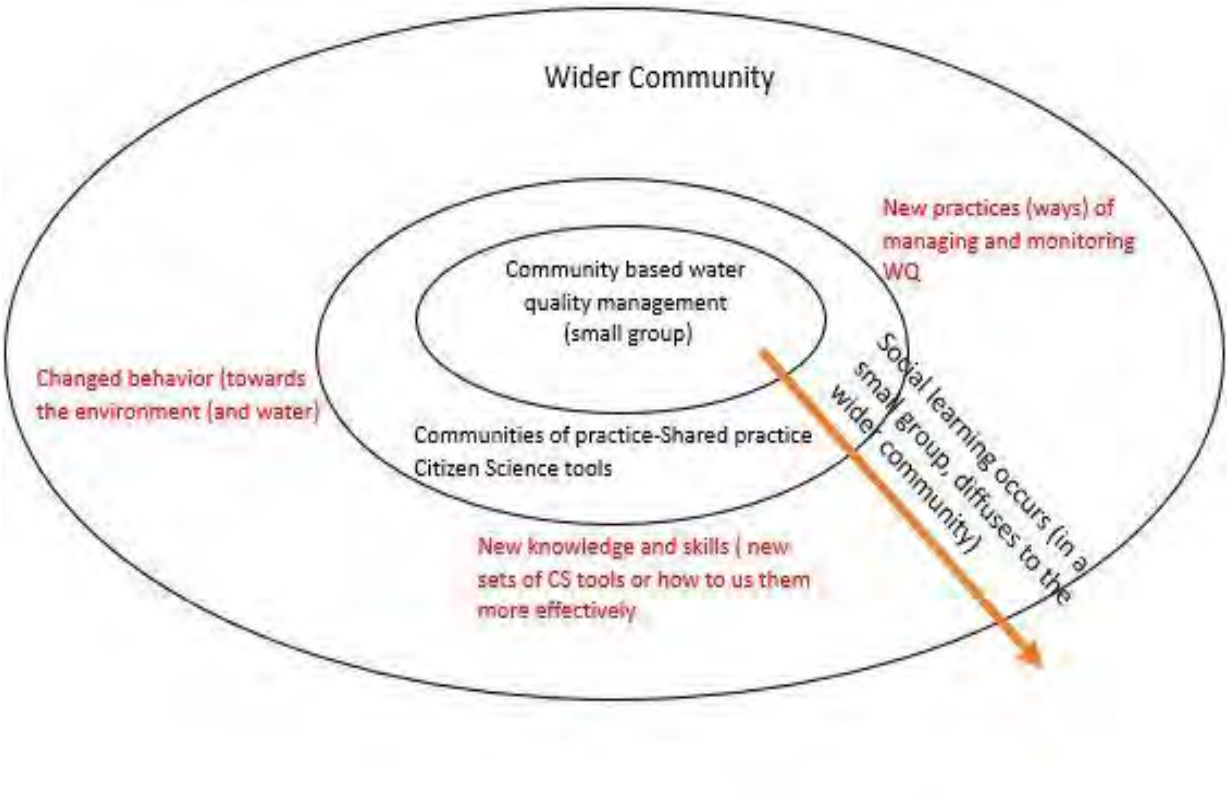


Figure 2.2: The relationship between CBWQM, social learning and citizen science

Figure 2.2 above shows the relationship between these different concepts, namely, community-based water quality management communities of practice (discussed below), social learning and citizen science. CBWQM allows for the constant interactions of individuals who have a common objective, which is to improve the water quality in their community. This constant interaction between a diverse stakeholder base can lead to relationships being formed, innovative ideas to solve water quality issues being shared and a common set of practices being formed. This type of environment allows for social learning and is responsible for characterising it (as per the Reed et al., 2010 descriptions thereof). CBWQM practices are a direct example of a community of practice, as they share a common interest, which is water quality. It is therefore important to understand how a particular CoP operates, in order for the right support to be provided.

2.5 Theoretical framing: Supporting communities of practice (CoPs) as a tool for scaling

The term community of practice (CoP) was founded by Etienne Wegner and Jean Lave in the early 1990s (Cox, 2005; Wenger, 2008) and emerged from an argument that stated that learning is not dependent on an individual but is rather a social process underpinned by cultural and

historical contexts. According to Pryko et al. (2017), social learning theory informing CoPs is recognised as unique because learning is seen as a transformative social process rather than simply the gaining of knowledge. Mohajan (2017) and Sánchez-Cardona et al. (2012) described communities of practice (CoPs) as a group of individuals who share a common passion or interest on a particular subject and interact on a regular basis in order to deepen their understanding on this topic. During this interaction, members of the community of practice create their own set of practices through constant interaction enabling the sharing of knowledge on a shared topic or problem. Although various types of communities exist, they cannot all be referred to as 'communities of practice'. Just because a neighbourhood is known as a community doesn't make it is a 'community of practice'. CoPs are ever evolving and take different forms as time progresses, but they are all characterised by three main aspects, namely the domain, the culture and the practice (Sánchez-Cardona et al., 2012; Vincent et al., 2018). Figure 2.3 below provides a diagrammatic representation of these three characteristics.

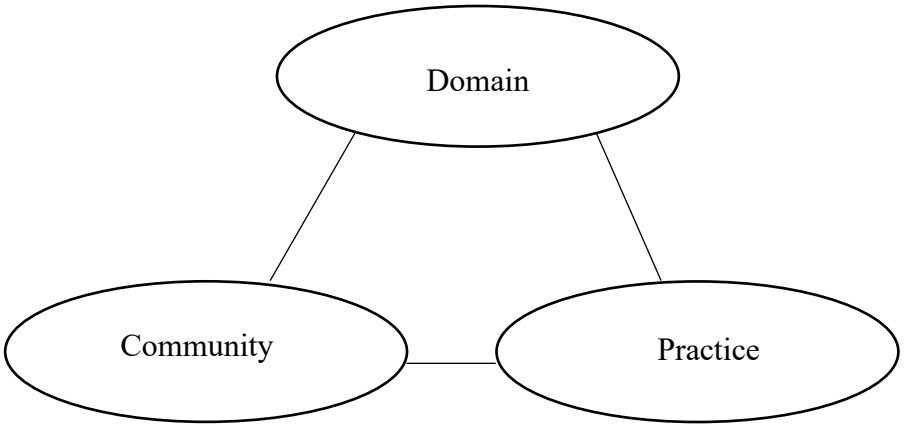


Figure 2.3: Diagram of the three elements that make a community of practice

The *domain* refers to the common issues that the community members experience on a regular basis. This shared domain is what keeps the members responsible and interested in the domain, therefore creating constant interaction amongst the community members. The domain is also the point of reference for its members from which they build their identity and also reminds members of the purpose of the CoP. The domain further guides members' learning process, and determines their level of contribution (Wenger et al., 2002). A *community* is only referred to as a 'community of practice' if they interact with each other in a variety of activities and on

a regular basis. As they continue to interact and learn from each other, relationships are built through commitment. A well-functioning community allows its members to inquire and ask difficult questions. Members of a such a community are always encouraged to share and participate. A community is regarded as one of the most important element of a CoP as they create the environment for learning to occur (Wenger et al., 2002). *Practice* refers to the ways of learning members have created and share to be able to engage in their CoP. This can be their own special 'way of conducting activities, such as a particular set of tools, documents or language' which helps them engage in their domain actively. This element enables knowledge to be created which gives identity to the CoP. This 'shared practice' is created by constant interaction and learning from each other. When these three components work together effectively, they are able to create a social structure that creates, maintains and shares knowledge (Wenger et al., 2002). According to the (Re) view(s) of Social Learning monograph (Lotz-Sisitka, 2012), social learning is supported and enabled by communities of practice, as they allow for constant interaction and engagement between stakeholders who share a common interest.

An example of a community of practice is the Makana Regional Centre of Expertise (RCE), described by Lotz-Sisitka et al. (2010), as a group of various stakeholders who are interested in different aspects of education to achieve sustainability. These stakeholders meet to share their experiences and knowledge with each other occasionally and strive to deepen their understanding of their educational practice through their continuous engagement. Through these meetings they aim to find solutions to educational problems in order to meet their sustainability goals. This group of stakeholders at the time the paper was written, was made up of individuals from different organisations, such as the Millennium Tree Planting Project which was a community-based organisation interested in biodiversity, health and climate and the Provincial Department of Education, which had an interest in improving teacher education. Although the organisational backgrounds of each stakeholder may be different, they share a common interest of finding educationally driven solutions to sustainability challenges (Lotz-Sisitka et al., 2007).

This community of practice, described by Lotz-Sisitka et al. (2010), offers a practical example of how individuals from varying backgrounds can be brought together by a common interest and share ideas and come up with solutions to address a common problem. According to Wals et al. (2009), this type of environment is what enables social learning to occur. As argued above, varying perspectives and expertise are needed to tackle environmental issues within natural

resource management. This type of environment with different stakeholder backgrounds allows innovative and creative solutions to emerge, which address complex challenges such as sustainability. Therefore, CoP theory is well suited to studying social learning in the context of CBWQM as it is a social process that seeks to address water quality issues through citizen science.

Wenger's structural model of a community of practice depicted in Figure 2.4 below was identified by Lotz-Sisitka et al. (2010) as a useful tool to strengthen the RCE practice for future application.

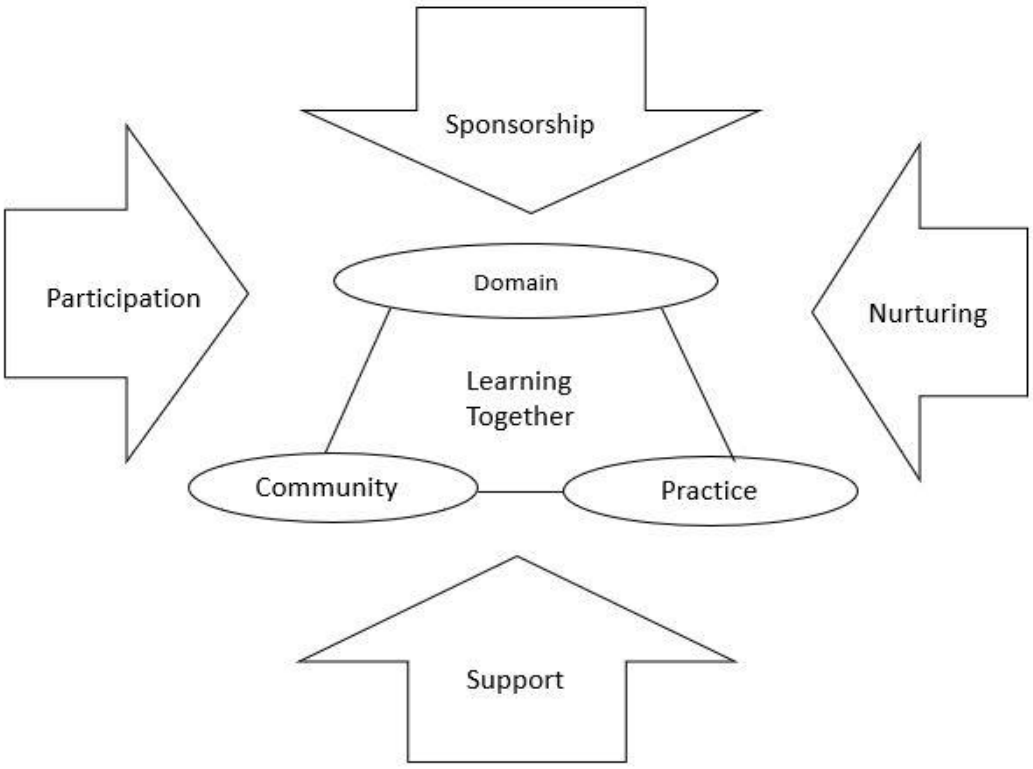


Figure 2.4: Wenger's structural model of a community of practice
(Wenger, 2007 as cited in Lotz-Sisitka et al.(2010)).

As mentioned above, Wenger (2008) emphasised that a community of practice consists of three components as shown in the diagram, namely the *community*, which is the group of people who share a particular interest, *practice* which involves the shared tools or techniques they are using to come up with solutions and the *domain* which is the shared interest issue being addressed. According to Wegner et al. (2002), a community of practice is enabled by four components namely support, participation, nurturing and sponsorship which support and strengthen a

community of practice. For the Makana RCE community of practice as described by Lotz-Sisitka et al. (2010), the following structures were identified as supporting factors: the support structure was in the form of a secretariat, which was responsible for setting up meeting venues and provided good communication and networking support. Nurturing support was provided through the Education Department at Rhodes University which provided access for the stakeholders through its connections to the international Education for Sustainable Development (ESD) research community and experts in the field. The participation component was strengthened by the establishment of working groups who meet to discuss questions that were co-created. A meeting was also held every four months for feedback and further discussions. In terms of the sponsorship component, no external funding was secured, but the Makana RCE used funds that already existed in the partner organisations. Lotz-Sisitka et al. (2010) argued that these supporting structures could serve as a tool to monitor the functionality of the Makana RCE. In my view these understandings of how the social learning of communities of practice can be supported are useful for the scaling of CBWQM practice as much stronger effort can be made to address the gaps within CBWQM CoPs, through identified potential scaling pathways.

CoPs exist all around us and look different depending on the type of domain they are built around. Within CoPs, participants or members interact regularly with other members because they find it valuable. Through these interactions, members share ideas, information and assist one another to solve issues. CoPs provide a learning and information hub for members, which allows knowledge to be formed, shared and developed (Wenger et al., 2002). These interactions build relationships between members, which creates a bond, sense of belonging and a sense of identity is built within them in relation to their CoP.

One of the research questions this study seeks to address is, what type of support is required to enable social learning in CBWQM CoPs? To attempt to answer this research question, we need to understand how CoPs can be cultivated, to be better supported for social learning to occur. Wenger et al. (2002) emphasised that CoPs occur naturally, therefore cannot be formed. But they can be cultivated, that is they can be supported to create an enabling environment for CoPs to be successful. For example, within organisations, CoPs can be supported through providing various resources, such as allocating time for CoPs to interact, valuing the learning process and knowledge created within them, therefore allowing members to contribute to organisational decision-making and encouraging CoP members to participate in their CoP (Wenger et al., 2002). Cultivating CoPs within organisations is beneficial for the organisation as CoPs are

able to address and solve a range of knowledge-related issues, that require a diverse range of stakeholders, which a CoP provides. In an organisational context CoPs are able to solve cross-departmental issues and streamline projects and activities that were not connected before (Wenger et al., 2002).

A study conducted by Viskovic (2006) investigated the journey of individuals becoming tertiary or university teachers, in three different contexts in New Zealand. The study explores how the varied institutions (which are regarded as CoPs in the study) which the teachers belonged to, were able gain the skills, knowledge and tools to become teachers through the CoP (institution) they belonged to. The study found that all three teaching institutions, namely, a university, the polytechnic and a multi campus wananga[8] varied in size, with the university having the highest number of full-time students (11 000) and the multi-campus having the least (1 500). This is important to note as this developed how the teachers interacted with the students and how the learning occurred. In all three case studies, teachers developed a repertoire or practice of teaching which included reading books and journals. The three teachers noted that their repertoires were dependent on the type of institution and the group of students they were working with. For university and polytechnic institutions, students were taught in classrooms using traditional assessment styles. In wananga, the teaching was home-based and focused on developing the confidence of the student in a particular subject. All three teachers noted that experiential learning was a foundational component of how they learnt to be a teacher as opposed to learning through theory. The study also showed that the teachers were well supported in their teacher development journey through offerings such as courses, seminars and workshops offered by their institutions. The teachers also expressed that they had a strong support structure in their colleagues. In conclusion, these findings reveal that the teachers developed their sense of identity of what being a teacher is, in their various institutions (CoP), and their teaching style (repertoire) from assessing how learning is taking place within their institution and the needs of their learners. This suggests that CoPs existed within these different institutions (Viskovic, 2006). Further the findings from this study reveal that an important enabler of the CoP as noted in Figure 2.4, was the support offered to the teachers in the form of seminars, which contributed to their teacher development journey.

Another study was conducted by Baker-Eveleth et al. (2011) to investigate the extent of social learning based teaching programmes to contribute to the development of a CoP. This study was

[8] In the education system of New Zealand, a wananga is a publicly-owned tertiary institution that provides education in a Māori cultural context.

conducted using two groups of students, a total of 94, enrolled in a yearly course carried out in a traditional classroom by the faculty team. The factors that were being assessed were learning climate, leader interaction and leader support. The faculty team met with the groups of students three days a week and offered support outside of their classroom sessions through one-on-one tutoring, practical sessions, meetings and mentorship meetings, to name a few. This type of learning climate or environment enabled social learning to occur, and consequently contributes to the development of a CoP. The type of learning environment created by the faculty team for the students influenced how the students were learning. This is through the learning culture provided by the faculty teams outside of the classroom for students, which allowed the students to inquire, actively participate in the learning and explore (Baker-Eveleth et al., 2011). This type of environment (traditional classroom and out-of-class learning) allowed for constant interaction between the faculty and students, which as mentioned earlier by Wenger (1998), contributes to CoP development. The support offered by the faculty team to the students demonstrated the commitment of the faculty team to the CoP, and encouraged students to participate actively. Wenger (1998) noted that CoPs are characterised by these four factors which are evident in the study: 1) CoP members feel a sense of belonging and attachment to the community they belong to which prioritises participation; 2) the identity of CoP members is defined by the community due to the commonly shared views and values; 3) CoP members believe that their participation in the CoP, has influenced their actions and way of life, and 4) CoP members participate more actively through practically engaging in CoP activities. In relation to these characteristics, the study found that the learning climate contributed to building the identity and sense of belonging of the students. The support from the faculty team also builds the sense of belonging for students (Baker-Eveleth et al., 2011). This case study provides a prime example of social learning occurring within a CoP, and how social learning can be better supported for development of a CoP.

A common critique of CoPs is ignorance of the power struggles that can arise within them. According to Blackmore (2010), the element of ‘community’’ within a CoP, can mislead one into assuming that issues such as conflict and disagreement do not arise in a CoP. One can assume that CoP members are always in agreement and do not share opposing views and ideas. But this is not the case. Social constructs such as class, gender, culture, religion and race can influence how members interact and participate in their CoP which can also be influenced by unequal power relationships.

2.6 Conclusion

In this chapter, I have drawn from various literature to deliberate on the issues around water globally and in South Africa, and unpacked the legislation that governs water at both scales. I have also provided a background summary of the contributing factors linked to Apartheid laws of the water quality challenges experienced in South Africa presently and provided a lens of how this has progressed over time through policy changes. Thereafter I explored the concept of citizen science, how it has come into action in South Africa, through CS projects and how South African legislative framework aims to create an enabling environment for this to occur. I went on to unpack CBWQM as a form of CBM, and described how it emerged and has evolved globally and in South Africa. I also linked this practice to policy and discussed what motivates this practice in South Africa in relation to literature. In the last section of this chapter, I discussed the theoretical framework in relation to social learning and provided examples of CoPs and social learning in action.

Chapter 3: Methodology

3.1 Introduction

Chapter 3 provides a detailed account of the research methodology, data generation methods and analysis techniques used in this study to investigate the potential of social learning to upscale CBWQM practices within two communities of practice (case studies) in KwaZulu-Natal. I further elaborate on the qualitative research methods that I used to identify how social learning was occurring within the two case studies (CoPs). This chapter gives detail on how the data was analysed, managed and stored to the lay the groundwork for Chapter 4. Finally, Chapter 3 concludes by elaborating on the ethical considerations considered in the carrying out of this research, as well as the measures taken to ensure rigour and validity in the study.

3.2 Research methodology

3.2.1 Qualitative research

There is no definitive definition of qualitative research, as it is not founded on a particular theory and is not attributed to a specific set of methods. Qualitative research tends to involve a multi-disciplinary range of methods and approaches. However, according to Astalin (2013), qualitative research can be defined as an approach that seeks to describe social phenomena through interpreting why things happen the way they do, and it draws on qualitative, rather than quantitative approaches. Qualitative research uses methods such as interviews and document analysis to generate data which I have implemented in my study (Hanock et al., 2007; Mohajan, 2018).

3.2.2 Case study research approach

This study is based on a qualitative case study approach. The case focused on social learning and how it can support and upscale CBWQM, particularly in the Mpophomeni and Baynespruit Enviro Champs (Case Studies 1 and 2, respectively) CBWQM Communities of Practice. According to Zainal (2007), case study research provides a unique advantage to the researcher, to understand and deeply analyse a social phenomenon within its context. It is particularly useful in conducting in-depth investigations of social phenomena, therefore I used this research approach to analyse and gain an in-depth understanding of the social learning process and the ways in which it can be supported for upscaling CBWQM. This research approach is suitable

for this study because it is effective in providing comprehensive information on qualitative human interactions, in this case the social learning processes occurring in the two communities of practice and how they are supported (Crowe et al., 2011).

The case study research method has also received wide criticism. Firstly, it is accused of lacking thoroughness as research tool (Zainal, 2007). This is based on the assumption that a case study researcher may have been swayed by their biased views in the research process, which would influence the findings of the research. Another criticism is that the small population size often used in case study research provides no grounds for generalisation of a finding to a large population (Zainal, 2007). This is also largely attributed to a popular criticism of case study research, which is its over reliance on one case, which makes the findings from it very limited. Although these limitations are valid and have been taken into consideration, Creswell (2003) argued that no research method is without its shortfalls, therefore the case study research method has been selected as appropriate for this study, to study social learning within CBWQM CoPs, and the findings from the study will be applicable to the South African context. Further, as noted by Zainal (2007), criticisms related to rigour can be overcome by using a combination of research methods (triangulation), which has been applied in this study (see Section 3.4).

3.2.3 Research orientation

This case study is underpinned by a research orientation of interpretivism, using inductive and abductive analysis. Interpretivism regards truth and knowledge as social and cultural constructs, influenced by one's environment, historical context, and experience (Ryan, 2018). It is therefore postulated that truth cannot be measured by scientific methods (Chowdhury, 2014). Humans cannot separate themselves from their beliefs and values and these will subsequently influence the way they perceive and interpret their reality. Any researcher will have innate bias in the interpretation of their data (Ryan, 2018).

According to Ryan (2018), interpretivist research can further be divided into four main types of approaches, namely, hermeneutics, verstehen, symbolic interactionism and phenomology. Hermeneutics is an approach applied to texts and documents to find a deeper meaning within them. Verstehen is the process of trying to understand a particular phenomenon through the perception and experiences of a participant, while symbolic interactionism is a process based on three core principles which can cumulatively be defined as the interpretation and the

development of meanings by people through their experiences and social context (Ryan, 2018). Interpretivism was applicable in this study because it provided the opportunity to identify and interpret themes from the raw data collected through interviews, document analysis and secondary desktop data. Additionally, it allowed me to make sense of the interaction of the participants within their CBWQM CoP, and consider how social learning was taking place within the CoP. This was done by gaining a deeper understanding through interpretivism, of the learning taking place within the CoPs and how their CoP was providing a conducive environment for the assumed social learning to occur, or not.

According to Chowdhury (2014, p. 8), "interpretivists look for meanings and motives behind people's actions like behaviour and interactions with others in the society and culture". Considering the above explanation, I sought to look for meanings and motives influencing social learning. This also served as a useful lens to understand the role and level of participation of the participants within their CoP and the forms of support enabling social learning to occur within these CoPs.

Further, two distinct reasoning styles were used to make sense of data, namely inductive and adductive reasoning. According to Thomas (2006), both these reasoning styles are used to analyse qualitative data. Thomas (2006) defined the inductive approach as the process of interpreting and processing raw data, through identifying themes or concepts from the data to make sense of it. This approach moves from specific observations to general conclusions of what a data set may be representing. Strauss and Corbin (1998) alternatively defined it simply in this way: "the researcher begins with an area of study and allows the theory to emerge from the data" (p.12). Strauss and Corbin (1998) further stated that themes and concepts derived from analysing raw data, are likely to provide a more accurate representation of reality than using theory only. It is for this reason that inductive analysis was used to interpret the raw data collected through interviews, document analysis and desktop questionnaire data. Moreover, inductive analysis allowed me to identify emerging themes within the data to understand how social learning was occurring within the CBWQM CoPs. I first employed induction and then abduction to deepen the analysis and describe the phenomenon.

Conaty (2021) defined abductive reasoning as the process of analysing raw data using a pre-set or existing theory to make sense of the data. If the findings within the data reject the theory, alternative theoretical frameworks are tested, or the scope of an existing theory is extended to make sense of the findings. This is the essence of abductive reasoning coupled with an objective

of gaining understanding of the new facts emerging from the data, through applying new theory (Conaty, 2021; Kovács & Spens, 2005). Within this study, abductive reasoning was employed through use of theoretical tools from Communities of Practice theory, to identify the shared domain, repertoire, and practice within the CBWQM CoPs, and to investigate the extent to which social learning was occurring within the CoPs.

3.3 Rationale for the case studies

3.3.1 Case studies and participants

As mentioned in Chapter 1, the Amanzi Ethu Nobuntu (AEN) programme is an initiative pioneered by DUCT in partnership with stakeholders from the uMngeni Ecological Infrastructure Partnership (Lotz-Sisitka et al., 2022). The AEN programme played a pivotal role in further upscaling CBWQM work, by piloting a blended finance model as a mechanism to support CBWQM initiatives within South Africa. It was therefore appropriate to study the CBWQM projects selected within this study (Case Studies 1 and 2) operating within the AEN programme, to further understand and respond to the latter part of my research question which is, to identify what support is required for scaling of social learning in CBWQM communities of practice.

As introduced in Chapter 1, two of these teams working under DUCT who were supported and funded through the Department of Science and Innovation (DSI) in the AEN programme, were the Mpophomeni Enviro Champs (Case Study 1, C1) and the Baynespruit Enviro Champs (Case Study 2, C2). See Figure 1.2 in Chapter 1 for a map of the study areas. Both cases were selected due to being practical examples of how CBWQM projects in South Africa operate at different levels and scales to meet a common objective of addressing water quality challenges at a community level (see Section 1.3.3). Further, due to my positionality in the study (see Section 1.4), as a project manager of the Mpophomeni and Baynespruit Enviro Champs within the AEN programme, there was a pre-existing relationship in which a sense of trust between the Enviro Champ teams and I had been built prior to the research, in both case studies. This relationship played a fundamental role in establishing research relationships with the Enviro Champs interviewed (see Table 3.1 and 3.2), and they were willing to respond openly and honestly during the interview process. Both case study areas being located in the uMngeni Catchment, meant that I was well positioned to select easily accessible case studies. This was especially important taking into consideration that the data collection process took place during the COVID- 19 pandemic, which placed many restrictions in terms of traveling to certain areas,

and made it difficult to interview participants. Therefore, selecting case study areas, that are located in the uMngeni Catchment, meant that I was able to easily access participants for interviews. Lastly, I decided to include these two case studies as part of this study as I felt that I could directly contribute to supporting and upscaling CBWQM work and projects, by applying the findings of this study from Case Studies 1 and 2, to CBWQM projects at DUCT and the AEN Programme.

There were nine participants in this research, three in Case Study 1, three in Case Study 2 with two of them being senior level managers of the Amanzi Ethu Nobuntu and one being a representative of DUCT. Mr L (Case Study 1) was amongst the first generation of Enviro Champs and continued to become a project manager of the second generation of Mpophomeni Enviro Champs. He currently works as an ecological technician at GroundTruth. Mr T (Case Study 1) is one of the founders and developers of the Enviro Champs concept – he has mentored the Mpophomeni Enviro Champs and continues to contribute and nurture the programme.

Of the four participants mentioned above, Mr F was the overall project manager for AEN with Mr V collaborating with him as DUCT project manager for the AEN DUCT projects. I also interviewed Ms N and Ms S, who were part of the first generation of Enviro Champs and continue to work as Enviro Champs to date. Ms N presently works at DUCT, as an intern within the Groen Sebenza internship programme. Additionally, as a continuation of her Mpophomeni Enviro Champ work, Ms N continues to collect water samples of the Howick Wastewater Outflow (HWWTW) at Shiyabazali community in Howick daily, to contribute to the improvement of the water quality of the uMngeni River. Ms S is currently an Enviro Champ working under the AEN programme, where she conducts biomonitoring activities on a weekly basis at WESSA. Ms B is currently the general manager of DUCT and has played a key role in securing funding and pioneering the AEN project at DUCT, at a senior management level. Ms B has overseen an array of CBWQM projects implemented at DUCT, such as the MSU project and the Adopt a River project.

3.4 Data generation method

Qualitative research seeks to provide a largely descriptive and detailed overview of a phenomenon in its natural context (Astalin, 2013). Three main research methods were employed in this study to generate data and are discussed further below, namely:

- Interviews, particularly semi-structured interviews

- Questionnaire analysis, and
- Document analysis.

3.4.1 Interviews

Interviews are a widely used data collection tool within qualitative research (Ryan et al., 2009). Lambert and Loiselle (2007) stated that interviews are effective tools for obtaining data from the interviewees of their experiences, beliefs, and attitudes. Although there is a variety of interviewing styles, they all share the common quality of employing questions to better understand a particular phenomenon being studied (Stuckey, 2013). There are three main types of interviews, namely, structured, semi-structured and unstructured interviews. They differ according to how the interview schedule is designed and conducted (Ryan et al., 2009). Semi-structured interviews are the most widely used (Stuckey, 2018). In this study, semi-structured interviews were used to gather data.

Semi-structured interviews were conducted with key stakeholders of the two identified communities of practice (see Appendix A for interview schedule). Due to the COVID-19 pandemic, there were significant changes to my data collection methods, particularly conducting of interviews. Of the nine interviews I conducted, three of them were conducted online, four conducted telephonically and only two conducted in person. This was in response to the COVID-19 pandemic lockdown regulations. With the two conducted in person, strict COVID-19 regulations were followed in order to ensure the safety of both participant and researcher.

Table 3.1 that follows provides further information of when the interviews were conducted with participants and why they were interviewed for this study.

Table 3. 1: Interviewees

Interviewee	Date of Interview	Reason for interviewing participant
Mr T	7/05/2021	Mr T was one of the developers of the Enviro Champs concept and has contributed to putting into practice and upscaling it to date.
Mr L	10/06/2021	Mr L is part of the first-generation Mpophomeni Enviro Champs and currently works at GroundTruth as a field technician within the river unit. He still plays a pivotal role in supporting CBWQM initiatives through providing training.
Mr F	10/05/ 2021	Mr F was the overall project manager for the AEN programme therefore was directly related to the upscaling of the practice.
Mr V	25/05/ 2021	Mr V was the DUCT AEN project manager and pollution officer who played a supportive role as a manager of CBWQM projects.
Ms N	08/07/2021	Ms N was part of the first generation of the Mpophomeni Enviro Champs and has continued to play a mentorship and supportive role in grooming the Phase 1 AEN Mpophomeni Enviro Champs.
Ms Nd	16/06/2021	Ms Nd was part of Phase 1 of the AEN programme, and was part of the Baynespruit team as a member and team supervisor.
Ms S	10/07/2021	Previous Mpophomeni Enviro Champ (first generation of Enviro Champs)
Mrs T	21/06/ 2021	Baynespruit AEN Enviro Champ
Ms B	17/06/2021	DUCT General Manager and co-leader of the AEN programme

Table 3.2 that follows provides a code name used to refer to each participant that I interviewed in my study (C1 = Case Study 1, C2 = Case Study 2) that will be used to reference the interviewees in the chapters to follow.

Table 3. 2: Index coding for interviewees

Code	Organisation/affiliation	Case study
Mr T	UKZN Fellow and founder of Enviro Champs concept	$C1_T$
Mr L	GroundTruth and first-generation Mpophomeni Enviro Champs	$C1_L$
Mr F	Overall Amanzi Ethu Nobuntu project manager	AEN_1
Ms S	Previous/Ex Mpophomeni Enviro Champ	C1 (EC_1)
Ms N	Previous/Ex Mpophomeni Enviro Champ	C1 ($EC_{2)}$
Mr V	DUCT	AEN_2
Ms Nd	Baynespruit Enviro Champ	C2 (EC_1)
Ms T	Baynespruit Enviro Champ	C2 (EC_2)
Ms B	DUCT	AEN_3

3.4.2 Questionnaire analysis

An analysis of qualitative questionaires with structured open-ended questions completed by participants who attended a Community Based Water Quality Management (CBWQM) workshop as part of the WRC National Review on Community Based Water Quality Monitoring (CBWQM) was also undertaken to offer broader perspective on the cases. Ethical clearance for these questionnaires was granted by the Rhodes University ethics committee in March 2019. I was partly responsible for administering these questionnaires and was part of the research team from DUCT, the organisation leading the National Review on CBWQM to which my case study contributes. I was granted permission to use these questionnaires in this study, as they have contributed to the larger WRC National Review on CBWQM, to which my study would also contribute. As mentioned in Chapter 1, a total of 31 questionnaires (representing CBWQM projects in South Africa) was reviewed, of which 22 (71%) were still operating and nine (29%) were inactive. This questionnaire data complements the findings in the interview and document analysis data to which my case study research contributes. To analyse the questionnaires, an analytical framework (Table 3.4) was used to guide the coding and identification of themes from the questionnaires.

Of the 31 questionnaires administrated, only 20 (that is approximately 65%) formally consented to the use of the questionnaire data for research purposes on the online questionnaire platform. Consequently, 11 of the participants (32%) did not formally consent to use of the completed questionnaire, even though they were aware that the questionnaire would be used for research purposes (this was part of the request to complete the questionnaire). Additionally, from the 31 questionnaires, 17 were disqualified from the dataset, as they were not thoroughly completed and did not represent projects within South Africa. This left 14 questionnaires correctly completed, and which represented CBWQM projects within South Africa, and which had formally consented to the use of the data for research purposes. Of the 14 projects represented by the questionnaires, only 10 were currently active. These projects are presented in Table 4.1, and the findings are further discussed in Chapter 5.

Analysis 1: focused on identifying how the selected CBWQM projects represented by the questionnaire data were learning together i.e. what domain, practices and repertoire (includes routines, actions, works, tools and ways of doing things) they are sharing.

Analysis 2: focused on identifying how social learning was happening within the CBWQM projects (outcomes of the social learning).

Analysis 3: focused on identifying the type of support (nurturing support, resources, participation networks, and other forms of support (e.g. shared citizen science tools) that were enabling or constraining social learning within the CBWQM projects represented by the questionnaires.

Analysis 4: focused on identifying potential scaling pathways along Scaling Pathway 1 (policy engagement, resources, and job creation) and Scaling Pathway 3 (capacity building) within the CBWQM projects (questionnaires), to better support and extend social learning within the CoPs.

3.4.3 Document analysis

A document analysis is an organised method of reviewing documents in order to gain a deeper understanding of a particular topic (Bowen, 2009). A document analysis was conducted of documents written on the Mpophomeni Enviro Champs CBWQM projects in South Africa. that were relevant to Case Studies 1 and 2 (see Table 3.3. that follows for a list of documents analysed). Reports for the Water Research Commission (WRC) on CBWQM initiatives formed the basis of the document analysis. These documents were chosen because they provided an

overview of the work of the Enviro Champs and how the social learning process is framed within these CoPs. The Mpophomeni Enviro Champs project (Case Study 1) and the number of CBWQM projects within South Africa noted within the desktop data (questionnaires) have been reviewed in the WRC final report, entitled *Alignment, scaling, and resourcing of citizen science-based water quality monitoring initiatives* (Lotz- Sisitka et al., 2022). There are also a number of other documents that have been published on the Mpophomeni Enviro Champ work, highlighted below in Table 3.3 (e.g. Ward, 2016 and Kolbe, 2014). The table provides an index code name for each document used within the document analysis, namely DM = Document Mpophomeni and DG= Document General.

Table 3. 3: Document analysis (DA) index table

Code name	Description	Why the document was analysed
DG 1	Lotz- Sisitka, H. et al., (2022). Alignment, scaling, and resourcing of citizen-based water quality monitoring initiatives	This document (report) was relevant to the DA as it provides an in-depth analysis of best practice examples of CBWQM initiatives in South Africa. The report was aimed at identifying factors that enable or constrain CBWQM in order to support the factors that enable the effective functioning and sustainability of CBWQM projects and identify what is required to upscale this practice at a local and national scale.
DM 1	Kolbe, A. (2014). Citizen science and water quality in the uMngeni catchment area, KwaZulu-Natal, South Africa. Master's thesis, Queen's University, Canada	This document is important as it investigates and provides a better understanding of how citizen science is addressing water quality challenges within the Mpophomeni township, through citizen scientists. This document further provides analysis of how social learning is occurring within the citizen scientist group in Mpophomeni and the potential scaling pathways for this type of work. This will contribute to answering the research questions of this study.
DM 2	WWF Nedbank Green Trust Project no.: GT5416 Review of the Enviro Champs Project in Mpophomeni (November 2016)	This document provides a summative review of the Mpophomeni Sanitation Education Programme (MSEP) which has evolved into and is currently well-known as the Mpophomeni Enviro Champs project, which I have selected as one of the case studies of this study. The purpose of the report is to provide a more detailed understanding of the factors that have enabled and contributed to the success of the Mpophomeni Enviro Champs project. to help upscale and implement these lessons to other CBWQM projects in South Africa. It is for this reason that this report is important in this study, to inform and identify scaling

		pathways for CBWQM projects and understand how social learning is occurring within them.
DG2	MSU Project: An evaluation of the Msunduzi DUCT Pollution and Monitoring, Maintenance and Community Education Project (Jim Taylor and Caroline Cenerizio, 2018)	This document was analysed because it provides a detailed evaluation of a CBWQM project, by investigating the factors that have enabled the success of the project and the potential scaling pathways within the project, that can be applied in other communities that want to implement similar initiatives in South Africa. This report also informed the research questions of the study, which sought to identify potential scaling pathways for CBWQM in South Africa and support factors that enable it.
DM3	EPWP Save Midmar Project close report (September 2018)	This report provides insight to Case Study 1 of the previously known MSEP project, now known as the Mpophomeni Enviro Champs project. It provides details of the shared practice and repertoire of this CoP, and the factors that have enabled and constrained it. This report describes how social learning is occurring within CBWQM CoPs, and how this can be upscaled and therefore directly informs the research questions of this study.

3.5 Data analysis

According to Vaismoradi and Snelgrove (2019), thematic analysis is an analysis technique used to systematically identify patterns or themes within a particular dataset. The first step to analysing the data involved transcribing the interviews which underpinned the analytical memos I created thereafter using the technique of thematic analysis

An analytical memo (see Appendix B) was used to inform my results chapter. For the analytical memo, I drew on CoP theoretical tools to identify the shared domain, repertoire, and practices to see what social learning was taking place in the CoP (i.e., I considered this with reference to the historical dates on the documents that I analysed, and to interview data collected) (abductive). This assisted me in recognising the common themes within the dataset and identifying whether social learning occurred within the two case studies, to what extent it had, the outcomes of it and how social learning was being supported in the COPs. To analyse the latter, I used Wenger's (1998) recommendations on support for social learning in CoPs: nurturing, participation, resources, and other support which I identified through inductive and abductive analysis. I then investigated how this could potentially be related to the two scaling pathways identified as relevant to this study (inductive). I structured the analysis according to my research questions to carefully address them. Additionally, I used the theoretical tools in

Communities of Practice theory to help me to identify the social learning occurring in the two Communities of Practice. The following analytical framework (see Table 3.4) was applied across three data sources, namely, questionnaires, document analysis and interviews, in an integrative way.

Table 3. 4: Analytical framework

Analysis	Themes
Analysis 1	How are they learning together, what is the domain that they are sharing, what practices are they sharing, what repertoire are they sharing? (Question 1)
Analysis 2	What are the outcomes of this SL in the two COPs? (Question 2)
Analysis 3	What support (nurturing support, resources, participation networks, and other forms of support (e.g., shared citizen science tools) are enabling or constraining the social learning (identified in Analysis 1 and Analysis 2 above) in the COPs (Question 3)?
Analysis 4	How can this support for social learning in the COPS potentially be extended to enable scaling for the COPs along Scaling Pathway 1 (policy, resources, job creation etc.) and Scaling Pathway 3 (capacity building)? (Question 4)

In this study an analytical memo (Appendix B) was developed in the form of tables for each analysis (1 to 4) in the analytical framework to address the research questions of the study.

- **Analytical memo for Analysis 1**: Core concepts from the theoretical framework were used to create the analytical memo which would identify characteristics that make up a CoP within CBWQM projects (Case Studies 1 and 2). These concepts were used as guiding key words to identify the shared domain, practices, repertoire for each case study. An open or 'anything else' column was created for this analysis to capture information that enables or constrains the functioning of the CoPs, outside of the core concepts of the theoretical framework mentioned.
- **Analytical memo for Analysis 2:** The analytical memo used guiding questions to guide coding and identification of themes relating to outcomes of social learning (that is, how social learning was happening and the results of it within the CoPs) within Case Study 1 and 2.

- **Analytical memo for Analysis 3**: Core concepts from Wenger's structural model of a community of practice (see Figure 2.4) were used to guide the coding and identification of themes relating to the factors enabling or constraining SL in the CoPs.
- **Analytical memo for Analysis 4**: used concepts from Scaling Pathway 1 (focused on policy, job creation and resources) and 3 (focused on capacity building) as a guide to identify potential scaling pathways and support required for CBWQM projects.

3.6 Research ethics

The protection of participants within research is imperative to avoid any harm that could potentially be imposed by the researcher in a study. This is ensured by the adherence and application of proper ethical principles such as freedom of choice, consent, and respect which aims to protect the participant and researcher, build trust, and obtain overall good rapport while meeting research objectives. Qualitative research involves human subjects, which requires a level of awareness of potential ethical issues that can arise in such cases (Aluwihare-Samaranayake, 2012; Orb et al., 2001). One way in which I made certain that the rights of participants were protected was through respect for each participant. I ensured this by not having a biased point of view of the participants' responses and not coercing them into a particular response. Additionally, I ensured that member checking was conducted during the data collection research process as well as showing respect for the participants' rights by ensuring that I obtained consent from them to participate in the study through consent forms. There was also allowance for the participants to decide whether they would like to remain anonymous. Freedom of choice for the participant was ensured.

Before engaging with key stakeholders like community members I obtained ethical clearance (see Appendix C) from the Rhodes University Ethical Standards Committee (RUESC). This process was important as it ensured that I had the permission of participants to be involved in the study. Moreover, it allowed me to look at the main issues and principles such as ethical risks associated with the research location that could potentially harm participants. This was limited by complying with COVID-19 regulations and maintaining social distancing with in-person meetings, while the rest of the interviews were conducted online or telephonically. Additionally, I respected the participant right to freedom and respect by obtaining permission from the participants as well as their organisations to participate in the study. The consent forms (see Appendix D) provided detailed information of what the research was about and allowed the participant the freedom to decide whether they wanted to be part of the study or not. I also ensured that their contributions were handled in an honest and responsible way through the

application of the technique of member checking. My positionality as the researcher also had a potential risk of influencing my study, which I limited by maintaining confidentiality of the information shared by the participant as well as ensured anonymity if requested. My researcher positionality also impacted on the study positively as it made some participants feel more comfortable to share in the interviews due to the existing working relationship that I had with them as a DUCT employee. This made the experience less intimidating for them.

In my ethics application I concluded that this research would be of benefit to society as it has potential to improve scaling pathways for CBWQM projects, through the process of social learning. This could lead to improved sustainability of CBWQM projects. This directly provides sustainable jobs for many individuals who can be absorbed as Enviro Champs in the programme. What led me to do this project was the growing need to identify scaling pathways for CBWQM to make them more sustainable so that they have a greater impact. This research will contribute immensely to the work we do at DUCT, in various CBWQM projects, as it has potential to inform areas that need to be improved to ensure that the scaling process is successful, as also argued in the WRC report (Lotz-Sisitika et al., 2022).

3.7 Rigour and trustworthiness

Rosman and Rallis (2010) argued that for research to be considered trustworthy it needs to not only follow the correct and ethical technical procedures of conducting research but must also ensure that the relational matters, that is, interaction with the participant by the researcher is carried out in an ethical manner. The relational aspect of the research is critical because it can be used to determine the overall trustworthiness of the research.

In addition to paying attention to relational matters by working carefully with research participants to build trust and confidence (i.e., practising 'everyday ethics' as per Rossman and Rallis, 2010), two techniques were used in this study to ensure the trustworthiness and validity of the data collected. These are member checking and triangulation. Member checking, also known as participant validation, is used to ensure the validity and trustworthiness of the data collected (Koelsch, 2013). During data collection and analysis, the researcher may express their personal beliefs and interests, which could potentially result in the data being biased. This can be limited through the process of member checking, which involves returning data results back to participants for them to verify the accuracy of the data collected and analysed by the researcher (Birt et al., 2016).

Another technique used in this study is triangulation, which can be defined as the process of working systematically with different research methods, theories, investigators, and observations to study a phenomenon in order to ensure validity and trustworthiness of data (Heale & Forbes, 2013). In this study, various research methods, interviews, questionnaires and document analysis were validated against each other to find the most accurate representation of the phenomena being investigated, which is social learning (Yeasmin & Rahman, 2012).

3.8 Data management and participant feedback

Data was stored on the personal computer of the principal researcher, and as a back-up, one the supervisors' Google drive housed on the Rhodes University server. For safety purposes, and for avoidance of unauthorised distribution, data was only provided on request for verification when needed. By the time this thesis was submitted, I had not yet completed the feedback process. However, I intend to provide feedback of the research outcomes of my study to the Mpophomeni Enviro Champs (Case Study 1), Baynespruit Enviro Champs (Case Study 2) and DUCT, in the next few months. I will share this feedback preferably in person as a presentation to DUCT and the two case study groups or alternatively through a report or on WhatsApp, respectively. Detailed management of data and analysis processes to ensure transparency and trackability was ensured by using index codes, transcription scripts and analytical memos for coding data.

3.9 Limitations

One of the limitations I faced as a researcher was in the data collection phase of the project in which I had planned to conduct in-person interviews with the participants. This process was delayed due to COVID-19 lockdown restrictions and ultimately resulted in the majority of the interviews being conducted online. Additionally, I had to change my case study site to one which is more local, i.e., the Baynespruit Enviro Champs due to the limitations of travelling to my initially selected site, due to the COVID-19 lockdown regulations. The newly selected case study (Case Study 2) provided easier access to participants as they were located within the uMngeni Catchment.

3.10 Conclusion

This chapter has given a detailed account of the methodology chosen for this study. Further, a comprehensive explanation of the data collection process was provided, considering the ethical considerations that may occur as a result of administering this research process. Therefore, this chapter has laid a strong foundation for the data that will be presented in Chapter 4, to investigate how learning is taking place within the CBWQM CoPs.

Chapter 4: Data representation

4.1 Introduction

In this chapter I present data collected from the data generation methods applied in this research study. The chapter begins by presenting the questionnaire analysis data, followed by the interview and document analysis data. This chapter presents the findings from the data sources using the analytical themes presented in Chapter 3 (see Table 3.4), presenting the findings as relevant to the research questions.

In this chapter, data is analysed per data type, as each data source offered different insights into the main research questions. The data presentation in this chapter informs the analysis in Chapter 5, in which I interpret and discuss the findings in more depth using triangulation, and discussion of the data in an attempt to address the research questions of the study.

4.2 Questionnaire analysis data

To present the questionnaire data I use all four of the analytical themes outlined in Table 3.4, as these are directly related and relevant to the questionnaire data. By analysing this secondary data using the analytical framework, I address two of the three sub-questions of my research which are:

(i) How are social learning processes taking place in CBWQM communities of practice?

(ii) What support (nurturing, resources, participation networks, and other forms of support) is enabling the social learning in these Communities of Practice and how can this potentially enable scaling of the CBWQM outcomes and practices?

The question on outcomes was not covered in the questionnaire, hence I did not analyse outcomes from the social learning process from the questionnaire data. The following data presentation will focus on presenting the data sourced from the questionnaire analysis completed by CBWQM participants, in active and inactive projects in South Africa as part of a broader WRC project, as mentioned in Section 3.4.2. This is because this research study is context specific to South Africa and focused on CBWQM projects in operation (see Section 1.3.3) located within KwaZulu-Natal, Pietermaritzburg. It was therefore advantageous to source data from South African CBWQM projects from which the lessons learnt and potential scaling pathways can be easily applied to the South African context, but most importantly which directly inform this research study. Additionally, the projects represented by the

questionnaires from the questionnaire analysis provided wider insights into CBWQM work and projects in South Africa. As mentioned in Section 3.4.2, 14 CBWQM projects are analysed in this study as presented below in Table 4.1. Table 4.1 outlines the project name, where the projects are located, the purpose of the project and the types of participants involved in the projects.

Table 4. 1: Descriptive information on selected projects from the questionnaire data (Q1= Questionnaire 1)

Index code	Name of project	Locational area of study	Purpose	Type of participants
Q1	Msunduzi DUCT River Sewer Line Discharge and General River Pollution Monitoring and maintenance (MSU project)	KwaZulu-Natal: Pietermaritzburg (Ashdown, Sobantu and Imbali area)	The primary purpose of the project is to reduce the sewerage leakages and surcharges, solid waste and other types of pollutants from entering the Msunduzi River with the aim of improving the overall health of the river.	DUCT employs a number of people (mainly community members) who are clustered in three teams , one in each township. These participants are referred to as DUCT River Care Teams and pollution monitors. The Msunduzi Municipality staff are also involved.
Q2	Mpophomeni Sewer Monitoring project	KwaZulu-Natal: Mpophomeni local area	Enviro Champs (champions of the environment selected form the community) were appointed to monitor sewer leaks, spilling manholes and water leaks. This data was useful to create graphical data to inform uMngeni Water and the local municipality of the state of the water quality in Mpophomeni which would potentially inform local decision-making.	Environmental champions (Enviro Champs), private organisations (GroundTruth), NPOs (DUCT) and Wildlands Conservation Trust and local water authorities (Umngeni Water).
Q3	WESSA Leadership seminars	Provincial, mainly in KwaZulu-Natal	The leadership seminars serve as a cross learning CoP, where different leaders from different contexts come together to discuss how they will address Ecological Infrastructure issues within their respective communities. From these discussions resource documents known as Stories of Change are created.	People in leadership positions - councillors, traditional leaders and municipal managers
Q4	Stream Assessment Scoring System (MiniSASS)	Used widely within the uMsunduzi-uMngeni catchment by CBWQM projects. The MiniSASS website is able to be accessed globally.	The project offers a River Health Index for monitoring streams and rivers.	The project is managed by Mr L (see Table 3.1 and 3.2) at GroundTruth using the miniSASS website www.minisass.org

Q5	UKZN - WRC K5/2718/4 Exploring the Evidence of Water-Energy-Food Nexus Linkages to Sustainable Local Livelihoods and Wellbeing in South Africa	Mpophomeni township outside Howick, Sobantu settlement in Pietermaritzburg	The Enviro Champs are responsible for collecting water quality data using citizen science tools from which the information collected will be used.	Community members
Q6	SAEON	Maputaland, Umhlabuyalingana area, North of KZN	Responsible for collecting water quality data using citizen science tools such as the clarity tube, velocity plank and miniSASS.	Lake Sibaya Conservation and Development Trust and local community members
Q7	Community Youth Water Programmes	Gauteng	It tries to find viable ways in which the municipality can work with the community on three overarching topics namely, schools, water efficiency and water demand management.	Municipality, community and NBI
Q8	Wize Ways Care	The project is located in the Ezimbokodweni and Folweni communities on the Mbokodweni catchment. It is a local project to the catchment.	The project carries out water quality testing every second week of the month in order to compare results. They primarily use citizen science tools such as mini-SASS, clarity tube, velocity plank and E. coli for bio monitoring. For chemicals and other testing, they use pills. i.e. for nitrates, phosphate, oxygen levels, pH.	Community-based organisations of all ages, Implementing agent i4water, Corporate funded - AECI Synergy projects and the Municipality
Q9	Palmiet River Watch	Palmiet River, KZN	The project monitors the Palmiet River and uses the results to engage with eThekwini municipality and industries in the area.	Local community of volunteers
Q10	Takeback Our Rivers	Aller River, New Germany, KZN	The project promotes healthy aquatic systems in the community and engages with schools, the community and local municipality to jointly address the issues.	eThekwini municipality, DUCT, UKZN, seven project beneficiaries, Kloof Conservancy
Q11	Vaal-Triangle primary schools	Vaal-Triangle, Johannesburg,, Gauteng.	The project's main purpose is learning about the importance of water, water bodies, water ecosystems, its conservation and management. Teachers use practical scenarios to carry out water activities in which they explain the concept of water	Primary school teachers from Vereeniging, Sebokeng, and Evaton Metsi-a-Lekoa Municipality

			management better to the class students, their families and friends.	
Q12	Khulumani Water for Dignity	Grahamstown East, Eastern Cape	This project was initiated in an effort to improve water supply and quality in Grahamstown East, which is a township area with limited water infrastructure. This project was initiated by community members who started the project in the hopes of gathering data to engage with Makana Municipality towards improving and increasing supply. The later phases of the project involved engaging the municipality based on civil rights – the Khulumani NGO partnered with the project at this point to lead this aspect of work.	Community members (lead), Rhodes University researchers, 50-100 participants, 51 water forums, 16 schools, tertiary students, officials
Q13	Witzenberg Water Savers	Nduli and Prince Alfred's Hamlet communities in Ceres, Western Cape	The aim of the project is to improve the water and wastewater situation in low income areas of the Ceres valley, which is critical for water and job security.	Run by community volunteers in Nduli and Prince Alfred's Hamlet communities in Ceres
Q14	Enkanini Water Hustlers	Berg River Catchment, Stellenbosch, Western Cape	The project was initiated to respond to water quality issues in the Mpophomeni community, the most common being spilling manholes. Citizen science tools such as miniSASS were used to monitor water quality of local streams of which the data is used to educate and raise awareness to the community. Door-to-door engagement was also used as a tool to raise community awareness of water quality.	WWF, Nedbank GreenTrust, Enviro Champs, Stellenbosch Municipality

4.2.1 Analysis 1: Learning together in a Community of Practice (CoP)

Analysis 1 focuses on how the selected projects in Table 4.1 are learning together as identified in the 14 questionnaires, i.e. the domain they are sharing, what practices are being shared, and what repertoires (includes routines, actions, works, tools and ways of doing things) are being shared. As stated by Mohajan (2017, p. 1),

> A community of practice (CoP) is a group of people who share a passion, a concern or a set of problems regarding a particular topic, and who interact regularly in order to deepen their knowledge and expertise, and to learn how to do things better.

Shared domain - monitoring water quality issues: As discussed in Chapter 2, Wenger (1998) noted that CoPs are only regarded as CoPs when they consist of these three elements: a domain, practice and community. The selected projects in Table 4.1 are characterised as CoPs (see Chapter 2, Section 2.4) as each project shares a domain which involves monitoring and engaging contextually relevant learning and management practices focussing on issues linked to poor water quality in order to improve river health. These water quality issues are shaped by factors including leaking sewers (or manholes) attributed to poorly maintained sanitation, sewer and water infrastructure, and illegal solid waste disposal. The shared domain leads to shared practices of monitoring and learning to manage river health. The MSU project (Q1) for example, aims to reduce sewerage leakages and surcharges, solid waste and other types of pollutants from entering the Msunduzi River with the aim of improving the overall health of the river. The shared domain extends to use of shared citizen tools. A number of the projects were also concerned with how the practice of CBWQM links water security to job security / livelihoods (Q13, 5, 2, 1), improved collaborative water governance (Q12, 10, 9, 7, 3, 2, 1), and children's learning (Q11, 7).

Shared tools to guide monitoring practice*:* Water quality issues are addressed in each project, though specific shared practices, the most common being the application of citizen science tools which include miniSASS, clarity tube, velocity plank, and the E.coli test (Q8, Q9, Q14, Q13). An example of this is the Mpophomeni Sewer Monitoring project (Q2) in which the Enviro Champs use citizen science tools such as the clarity tube, Geo ODK app and miniSASS to gather and monitor water quality information for the local Mpophomeni area. The WWS project (Q13), located in Ceres, Western Cape similarly uses the Enviro Champs model to address the poor water quality issues faced in the Nduli and Prince Alfred's Hamlet communities. These Enviro Champs use citizen science tools to monitor and report sewer spills

and water leaks, lead community clean-ups, and awareness-building activities through door-to-door campaigns, drama groups and other public events.

Education and learning to support monitoring practice: The Vaal-Triangle Primary School project (Q11) employed environmental education and awareness as a tool to educate schools in the Vereeniging, Sebokeng and Evaton area on the importance of water, water bodies, water ecosystems, its conservation and management. Similarly, in the Khulumani Water for Dignity Project (Q12), a door-to-door survey was conducted by volunteers (who comprised local school and community water boards) to collect the experience of water and the perceived impacts on water quality of community members. This data was analysed and used to educate the community of their water rights at a municipal level, and to encourage community members to engage with the municipality to improve service delivery. Both these shared practices reflect Mohajan's (2017, p. 1) view that "a CoP is characterized by mutual learning, shared practice, inseparable membership and joint exploration of ideas".

Learning together in the CoP: The participants in the Mpophomeni Sewer Monitoring Project (Q2) also have a shared learning focus, and learn together through training days being conducted every Tuesday for the Enviro Champs, which included learning about how to use the Geo ODK App and team building. In these training sessions, the Enviro Champs practice how to use the different citizen science tools, raise any challenges and issues they may have in using the tools and share their knowledge and experiences with each other. This constant engagement allows the Enviro Champs to have a deeper understanding of their practice (the tools they use and the work they are doing) which consequently allows for social learning to occur. These meetings also provide a platform for the Enviro Champs to find innovative solutions to the water quality problems they face in the Mpophomeni area. Additionally, the participants are individuals from different backgrounds and experiences. According to Wals et al. (2009), it is this type of environment with stakeholders from different backgrounds and with different expertise that enables social learning to occur. In a review of the Enviro Champs project in Mpophomeni, Ward (2016) supported Wals (2009), noting that the Mpophomeni Enviro Champs are supported by strong linkages with environmental and water quality related organisations.

Of the projects located in the Western Cape and the Eastern Cape, namely the WWS project (Q13) and Khulumani Water for Dignity (Q12) respectively, learning occurred through natural resource management training and activities enacted by the water board. These activities

included water quality measuring, water leak and sewer monitoring, the implementation of community education and awareness activities such as door-to-door visits, theatre shows and biomonitoring and community workshops for learning about sanitation improvement techniques. The shared practice is what allowed learning to occur within the community and in schools.

4.2.2 Analysis 3: Support that enables or constrains social learning (SL)

Analysis 3 focuses on what support (nurturing support, resources, participation networks, and other forms of support (e.g. shared citizen science tools) enable or constrain the SL in the COPs, as identified here in the questionnaire data.

Enabling support*:* Of the projects located in KwaZulu-Natal, the UKZN (Q5) and Mpophomeni Sewer Monitoring (Q2) projects highlighted the financial support through monthly stipends that the Enviro Champs received for the work they do. The original source of funding that supported the Mpophomeni project when it started in 2011 was from uMngungundlovu District Municipality (UMDM) with additional funding from the WWF-SA Nedbank Green Trust and the Expanded Public Works Programme (EPWP). This ensured that the work that the Enviro Champs did was sustainable, and has a longer impact as well as ensuring that the CoP was not weakened. The Wize Ways Care project (Q8) is primarily supported through monitoring tools as well as safety equipment.

According to the Lotz-Sisitka (2012), social learning is sustained and assisted by communities of practice, as they enable constant interaction and engagement between stakeholders who share a common interest. Wenger (1998) stated that constant mutual engagement between individuals in a shared domain is what characterises a CoP. In the projects outlined in Table 4.1, there is evidence that there has been constant engagement on the shared domain of addressing factors that contribute to poor water quality in their areas. It is the abovementioned enabling factors such as financial and resource support that allow for the continuation of CBWQM projects, and subsequently a continued interaction of participants in a CoP, which provides an enabling environment for social learning to occur.

Lack of support / constraints to social learning*:* As discussed in Chapter 2, Wegner et al. (2002) stated that a CoP has four enabling factors, namely, support, participation, nurturing and sponsorship which support and strengthen a community of practice. From the questionnaires, it was possible to identify constraints to social learning, including factors such as *lack of*

political support and *lack of support from municipal authorities* in the Mpophomeni Sewer Monitoring (Q2), WESSA Leadership seminars (Q3), and the Community and Youth Water Programmes projects located in KZN (Q7), which were not only constraining the projects physically, but also weakening the CoP. This lack of support was also experienced in the WWS project (Q8), as the project stated a lack of a "cooperative relationship with the municipality and lack of a local project co-ordinator or senior volunteer to support the WWS on a full-time basis" as some of the limiting factors of the project. Although these factors limit the CoP from functioning well, they also indirectly limit social learning.

Another limiting physical issue which directly limited most of the projects, is unsustainable funding (Q3, Q12, Q13). The WWS project (Q13) identified a lack of funding to provide ongoing stipends for the Enviro Champs as one of the limiting factors of the project, which is linked to limited funding to support CBWQM projects. This was also noted by the WESSA leadership seminars group (Q3), which suffered from insufficient funding to conduct training. The Khulumani Water for Dignity (Q12) and the Witzenberg Water Savers project (Q13) also listed the *lack of funding*, *capacity to manage funding* and *poor municipality buy-in* as factors that limit the project and therefore limit the CoP, and its potential social learning processes. According to Reed et al. (2010), social learning is characterised by constant interaction of individuals who belong to a CoP. Therefore, it is this constant engagement of participants in a CoP, that enables social learning to occur. When project funding is unsustainable, the project usually ends. This has implications for the participation of the Enviro Champs in their social network as they are bound to meet less regularly when the project ends and this constrains or disrupts social learning, with lack of funding also affecting projects' ability to offer training as in the WESSA leadership seminars group. An interesting finding identified within the SASS project (Q4), which constrained the project was lack of capacity and funding to host and maintain the miniSASS website.

4.2.3 Analysis 4: How support for social learning in the COPS can potentially be extended

As indicated earlier, my study focuses on two scaling pathways, namely Scaling Pathway 1 – political economy and policy support – and Scaling Pathway 3 which looks at capacity development.

Policy engagement and support*:* Policy engagement and support involves all forms of political support and policy support needed to ensure sustainable funding and other support

(e.g. political support) for community groups involved. As indicated above, and in Table 4.1, a number of projects felt that there was inadequate policy engagement and support which included lack of political buy-in, municipal support, and government funding for the activities. These are therefore areas that can be extended in future. Additionally, livelihood support and enterprise development were identified by Wise Wayz Care (Q8) as a solution and a scaling pathway (Scaling Pathway 1) to the failing approach of volunteerism with no payment for ecosystem services which relates to the unsustainable funding of the projects.

***Capacity development**:* Capacity development includes the means of providing formal and non-formal training and support to individuals in order to upskill and develop them to do CBWQM work as well as develop their own personal endeavours (Lotz-Sistika et al., 2018).

According to the Witzenberg Water Savers project (Q13), there is a need to further capacitate Enviro Champs in a wide range of skills otherwise overlooked such as administration, enterprise development and as well as environmental services. This directly relates to Scaling Pathway 3, which looks at informal training being offered to Enviro Champs that will benefit the work they do, as well as their personal interests.

The MSU project (Q1) identified technology, that is, the use of YouTube and social media platforms such as Facebook to share information on the project, as tools that can be used to capacitate the Enviro Champs. Additionally, the Khulumani Water for Dignity project (Q12) identified factors such as "developing community capacity to raise and manage funding accountability" as important way for the Enviro Champs to help raise funds for the projects.

Connection between the scaling pathways: Both these potential scaling pathways speak to capacity development of the Enviro Champs (both informal and formal) and are practical measures that can be implemented to upscale CBWQM work. All the projects engage with policy at a national and provincial level through policy frameworks such as the National Water Act, SDGs, IWRM Plan, local and municipal development plans as well as through the schooling curriculum which are potential scaling pathways for the project. For example, the WESSA Leadership seminars project (Q3) highlighted the need to develop a relationship with CoGTA as a potential scaling pathway. This means that there is evidently opportunity for these projects to leverage the political relationships they already have in order to strengthen Scaling Pathways 1 and 3 which already exist within their projects.

4.3 Interviews

As above, to present the interview data I apply the analytical framework outlined in Table 3.4, which seeks to investigate the social learning process occurring within the two CoPs (see Section 3.3) represented by the nine participants (see Table 3.1 and Table 3.2), to identify the support required to upscale CBWQM within CoPs. I have used an analytical memo (see Appendix B) to categorise the interview data according to the themes described in the analytical framework (see Table 3.4). As a result, I address all three of my research questions through insights found in the interview data.

Within the CBWQM projects, participants share their own special language, which forms part of their shared repertoire and practice to refer to the tools they use to monitor water quality. Table 4.2 provides a more detailed explanation of these tools to provide context to the reader of shared repertoire that will be referred to in Analyses 1 to 4 below.

Table 4. 2: 'Language used' to refer to activities and tools in the CBWQM CoPs (Case Studies 1 and 2)

Tool or activity used within the CBWQM CoP	Definition
Enviro Champ	Environmental champions who are responsible for championing environmental health through raising awareness and educating the public on the environmental related issues (Ward, 2016).
Citizen science tools	Tools that can be used by ordinary citizens (non -scientists) to monitor the water quality of a water body. The tools employed within these CBWQM projects were: • Mini Stream Assessment Scoring System (miniSASS): a simple (citizen science) version of the SASS5 biomonitoring technique used by water scientists to monitor water quality. • Velocity Plank: a transparent board used to determine the speed at which a river flows. This is a simpler Transparent Velocity Head Rod (TVHR) founded in the USA. • Clarity tube: a meter-long transparent tube used to determine the turbidity of a river (Capacity for Catchments, n.d).
Digital tools used to monitor factors contributing to poor water quality	
Field Survey app	An open source, mobile-based app used by Enviro Champs to collect citizen science data (Taylor & Cenrnezio, 2018).
Geo ODK app	A citizen science, open source mobile-based app or platform, used by Enviro Champs to work with citizen science data ranging from activities such recording the number of spilling manholes and household visits (Lotz-Sisitka et al., 2022).
Community engagement tools	
Door-to-door education	A form of community engagement aimed to raise awareness and educate community members on environmental issues led by Enviro Champs, in which they share information in the form of pamphlets to community members (Ward, 2016).
Trashion show	An Enviro Champs initiated educational activity aimed at educating kids on the importance of correct waste disposal and recycling. Kids are invited to create fashionable items to showcase using recyclable waste (Ward, 2016).
River walk	An activity usually initiated by the Enviro Champs, in which they involve the community in a walk alongside a river. During the walk the Enviro Champs educate participants on various water issues.
Eco clubs/Enviro clubs	A community (primarily school-based) education engagement tool based on the well-recognised Eco-Schools programme by the Wildlife and Environment Society of South Africa (WESSA). The Enviro Champs engage with schools on a weekly basis through various education activities about proper management of environmental resources (Ward, 2016).
Street theatre productions	A community engagement and awareness raising activity initiated by the Mpophomeni Enviro Champs. These plays are designed to raise awareness within the public of the water quality and environmental issues faced in the community while opening up space for dialogue relating to these topics (Ward, 2016).

4.3.1 Analysis 1: Learning together in a Community of Practice (CoP)

Analysis 1 focuses on how the participants within CBWQM projects are learning together, this time as described in the interviews i.e. what is the domain that they are sharing, what practices are they sharing, what repertoire (includes routines, actions, works, tools and ways of doing things) are they sharing?

Similar to the findings in the questionnaires, the domain the participants within a CoP share is a poor water quality issue within the different communities their projects are located in (Case Studies 1 and 2, Section 1.3.3). These water quality issues are attributed to factors such as solid waste due to illegal dumping, leaking sewers and open manholes. According to Lotz-Sisitka et al. (2022), the Mpophomeni community has faced the issue of spilling sewer manholes and illegal dumping of solid waste for many years. This shared domain affecting both the quality of life of the community and the water quality is what led to the establishment of these CBWQM CoPs (Case Studies 1 and 2). Lotz-Sisitka et al. (2022) supported this statement implying that these water quality issues within the Mpophomeni area led to the start of the Enviro Champs initiative.

Table 4.3 below provides a summary of the three components that characterise the CBWQM CoPs referred to in this study (Section 1.3.3), namely, the domain, shared repertoire, shared practice and community, which reflects the social learning in the CoP.

Table 4. 3: Summary of the shared domain, practice, repertoire and community within the CBWQM CoPs (Case Studies 1 and 2)

Domain	Shared repertoire	Shared practice	Community
• The shared domain within Case Studies 1 and 2 is a poor water quality issue, attributed to leaking sewer manholes and illegal dumping sites.	• Use of digital apps such as the Field Survey and Geo ODK app to monitor illegal dumpsites, leaking sewers and water leaks. • Use of citizen science tools, namely miniSASS, velocity plank, clarity tube and E-coli ware tube test. • Use of community engagement and awareness mechanisms such as door-to-door education, river walks, eco-clubs and the trashion show. • Interaction within the CoP: the CoP participants worked together for the whole week, conducting activities such as monitoring of sewer and water leaks and illegal dumpsites. They also meet every Friday for 'toolbox' training, in which they discuss the issues and challenges they faced within the working week.	• Use of 'special' language such as citizen science tools, door-to-door education, trashion show, Enviro Champ and naming /labelling of leaking sewer manholes according to the initials of the CoP member in order to monitor it (Case Study 1). • Use of WhatsApp as a communication tool within the CBWQM CoP, in which they shared weekly progress of work activities and tasks achieved with their NGO line manager . • Attendance of training on a monthly basis comprising of soft (communication in the workplace and report writing) and technical skills such as the using the Geo ODK and Field Survey app.	• Community refers to the participants within the CoP also known as the Enviro Champs. These participants comprise of the old and new 'generation' of Enviro Champs who are both young and old. These participants also have varying backgrounds and came together to solve the common issue (domain) of poor water quality. These CBWQM CoPs are referred to as a community, as there is mutual engagement within the CoP between participants as they interact with each other on a daily basis and apply their shared practice to solve water quality issues.

Of the nine participants interviewed, four identified leaking sewers as the factor most contributing to worsening water quality. These four participants are actively involved in a CBWQM CoP, specifically Case Studies 1 and 2 (see Section 1.3.3). Within these CoPs these participants, also regarded as Enviro Champs, are responsible for monitoring and reporting factors that lead to poor water quality, namely illegal dumpsites, spilling manholes and leaking sewers. These Enviro Champs have developed a shared repertoire and practice to address the water quality issue faced within their CoPs. According to Ms N, in Case Study 1, "leaking sewers is the issue, as a lot of them pollute the river". Ms Nd, in Case Study 2, agreed with this statement, as she highlighted that the "common issue was leaking sewers that were so bad that they were unbearable for the surrounding residents. Even when they were reported they weren't fixed." These leaking sewers directly affect the water quality of the rivers located in Case Studies 1 and 2, subsequently leading to the Enviro Champs using citizen science tools, to address these issues. These observations and tools form part of the shared repertoire.

As stated by Ms Nd,

> We used CS tools to carry out bio monitoring activities. We did miniSASS to measure E. coli, and the velocity plank to measure the speed of the river. These tools helped us determine the overall health of the river. We also used WhatsApp to communicate what we are doing and send a picture of what we have done, and if anyone needs help we communicated this on the group. We also used the Field Survey app to record illegal dumpsites, open sewers and storm water drainages that blocked litter.

This shared repertoire forms the shared practice. The shared practice, according to Ms Nd, also included conducting door-to-door education with the community to raise awareness on the impact of their actions on the river, as well as meeting every day on a weekly basis to discuss any challenges or highlights they may have experienced throughout the week. Within these meetings, individuals within the CoP in Case Study 2 (see Section 1.3.3), discussed challenges and issues that they faced. Ms N additionally stated that their shared practice included monitoring the sewer leaks using the Geo ODK app, conducting river walks, hosting trashion shows for the kids, and meeting twice a week every month. She also added that they met during training sessions and meetings. Training was linked mainly to issues with the Field Survey app conducted by Mr L (see Tables 3.1 and 3.2). Within this shared repertoire these CoPs developed their own shared practice. These shared tools that have strengthened the shared repertoire and subsequently shared practice of the participants within their respective CBWQM projects.

4.3.2 Analysis 2: Outcomes of social learning within the CoP

According to Reed et al. (2006), learning is only characterised as a social learning process when there is evidence of an altered understanding within an individual, this change diffuses beyond the individual into the wider CoP and happens through social interaction within a CoP. Social learning was evident in both Case Study 1 and 2. Ms S stated that within her project (Case Study 1, see Section 1.3.3), she had learnt the significant importance of water, and why it needs to be stewarded well through reusing it in various ways such as watering with grey water, creating educational games to teach children about the importance of water and using rainwater for cooking and cleaning. Recently she bought a Jojo tank, a large plastic container, mainly used in South Africa to collect and store rainwater used for domestic activities within and outside of the household (About Jojo, 2022), which she uses to catch rainwater subsequently used for washing and cleaning. This supports Reed et al.'s (2006) claim that social learning is characterised by a change in understanding within an individual, which has led to Ms S changing her behaviour and purchasing a Jojo tank, attributed to her exposure and experience in the Enviro Champ work (which further supports Reed et al.'s (2006) statement that social learning occurs through social interaction within a CoP). She commented "my understanding of the environment changed a lot, I had minimum understanding of the environment. I didn't know about alien plants, CS tools and the existing aquatic invertebrates". It is this outcome of social learning that has occurred internally which has changed the way Ms S interacts with the environment and others.

Ms Nd also described how her behaviour towards the environment has changed by being a member of her CoP (Case Study 2, Section 1.3.3):

> I learnt a lot with being part of the AEN project. I gained a lot of knowledge about things I didn't know, for instance, using tools such as the Velocity plank. Now I know that when I take care of the environment I take care of the future. When a tap leaks we lose water. I never use to care that the tap was leaking or open, but through the programme I've learnt the importance of conserving nature and water so kids get to have water in the future. I also realised that most environmental problems such as global warming is caused by the activities we do as people.

She further stated how her changed understanding of the environment has led to her changed behaviour: "I am planning to start a small garden, because this helps us get closer to nature and

maybe over time it will grow bigger. We gain a lot from nature as people although we don't take care of it".

Mr V argued that "this will help me stay connected to nature which is very important to us as people". Mr V spoke about this change in behaviour within an individual and consequently within the CoP, and noted that the community is dependent on the longevity of the CoP (or how long a CoP has existed and been active within a community). According to Mr V, "what brings about that change is the groundwork that has been laid at the start in the communities that we work in". An example of this is the Imbali and Sobantu community which has a history of more than four years of Enviro Champ work. Mr V commented that,

> In Imbali and Sobantu, the Enviro Champ work and CBWQM project (s) have become part of the culture of the community and the older Enviro Champs have become ambassadors that lead by example for the new generation of AEN Enviro Champs within the AEN programme. The new generation of Enviro Champs learns from the original ones (pioneers). They also engage with them and there is a sort of mentorship and guidance from the pioneers who grew this Enviro Champ work.

This statement further reflects that within a CBWQM CoP, social learning occurs more effectively through the social interaction of members who have longer experience in Enviro Champ work, who then share that knowledge with the newer Enviro Champs. Ms N also stated that her understanding of the environment has changed as a result of being a member of her CBWQM CoP (Case study 1. Section 1.3.3). She commented that

> Yes it has, especially the way I understood river health. I didn't realise how much impact human actions had on the environment. I didn't realise the importance of the environment and the way we create waste and pollute. I have tried to reduce these factors.

She also stated that one of her key takeaways from being a member of a CBWQM CoP is the importance of educating the community on the work that they do, and the importance of living in a sustainable way.

Ms T also indicated how her understanding with the environment has changed through her social interaction within her CoP (Case Study 2, Section 1.3.3). She commented "it has changed significantly – I have wanted to continue with the work thereafter. I've realised that I cannot live without water and the environment, especially since we worked with water." She

further stated that she rediscovered while working in her CoP her love for farming, which was supported by the 'organic farming methods' training they had conducted in the CoP, to support sustainable use of water.

It is evident from the abovementioned statements of the participants, that a change in understanding occurs through social interaction within a CBWQM CoP, which leads to change in behaviour. This changed behaviour within a CoP member further diffuses to the wider community (particularly family and friends) when the individual (member of a CoP) decides to implement mechanisms that contribute to improving and conserving water such as the consideration of one of the CoP members to purchase a Jojo tank.

4.3.3 Analysis 3: Support structures/factors that enable or constrain social learning

Enabling and constraining factors to social learning are heavily dependent on the effectiveness of the CoP, and how supported and nurtured it is. According to Lotz-Sistika et al. (2007), merely forming a CoP to address a particular concern is not sufficient, as it needs certain elements to operate successfully. The elements that make up a CoP are the community, shared practice, shared repertoire and the domain; when these factors are affected, it impacts on the CoP as a whole. As discussed in Chapter 2, Wenger's structural model (Lotz-Sistika et al., 2007, p. 21) identifies four factors that strengthen a CoP internally. These components include support structures, nurturing and conceptual support, participation and sponsorship. When these elements are not at play, the CoP is weakened, thus affecting social learning. This is because social learning is only characterised as social learning when it occurs through constant interaction also known as mutual engagement of individuals, within a community (Reed et al., 2006).

The four elements outlined by Wenger's structural model, are employed in this analysis to investigate the enabling and constraining factors of social learning as identified in interview data.

Support needed / constraints to the social learning*:* According to Mr V, the *lack of community interest*, is a missing element within communities where CBWQM projects are implemented. He stated that "homework needs to be done before projects are implemented in places. It can't be a copy and paste process. It becomes difficult to implement the project when the community/environment is not welcoming or conducive to that sort of CBWQM initiative."

This *nurturing support* is required to strengthen the CBWQM CoP, therefore providing a conducive environment for social learning to occur.

Additionally, Mr V and Mr L identified *a lack of sustainable funding* as a constraint, which hinders CBWQM projects and subsequently, the CBWQM CoP from operating. Mr V stated that "CBWQM are good initiatives and well thought out but in most cases the duration of the project is usually a year or two. Change comes through the projects but it is not sustained." Mr F and Mr T agreed with Mr V's statement on the lack of financial support, as they identified the lack of sustainable funding as the most constraining factor to the continuation of CBWQM projects. Lack of finances contributes to lack of incentives and overall lack of *support for the livelihoods* of the Enviro Champs as inconsistent funding does not give them *security*. When there is no mutual engagement (i.e. constant interaction of the Enviro Champs in their shared practice within their CoP) due to unsustainable funding, an essential component is weakened within the CoP, which is the shared practice and community. Mr F stated that "there is a need for sustainable funding for projects, not only once-off. If the project is sustained the project is sustainable which helps to see the impact of the CBWQM projects." Therefore, sustainable funding is a necessary element to ensure that CBWQM projects continue. Mr F identified funding from the government as a part of good nurturing support for CBWQM projects. According to Mr F, "I think my experience of AEN phase one has been that the support from central government – I'm going to call them central government through DSI, central government structures – has been very good. Additionally, Mr F argued that there has been *lack of municipal support* for CBWQM projects, particularly with the AEN programme. He commented that,

> We've got a very disappointing input from the municipalities, and we can understand why in the bigger picture, because, you know, broadly, municipalities have been mismanaged, there's been a lot of fraud, there's been a lot of a lack of skills, and they're really on the back foot.

Mr L agreed with Mr F by stating that there was a need for sustainable financial support to fund CBWQM projects.

Lack of technical and training is another constraining factor for CBWQM CoPs, as this inhibits the CoP from operating effectively in their shared practice; the Enviro Champs rely on training provided by CBWQM organisations to capacitate them to do the Enviro Champ work. This training includes, but is not limited to, Field Survey/Geo ODK app use, use of citizen science

tools, as well as door-to-door training. According to Mr L, there is a need for *more consistent training,* particularly with regard to the Field Survey app training: "Field Survey app training was short term, and the consequence of that when the project started was that there were a lot of data gaps, with the AEN programme". He also commented that this training needs to be tailored to the activities the Enviro Champs engage in on a daily basis. Furthermore, Mr V and Mr L emphasised *the need for soft skills training focused on social engagement skills*. According to Mr V, training is particularly necessary in *community engagement*, as most of the CBWQM involves working and engaging with the community. According to Mr V,

> We take this social component for granted in terms of working with people because we think it's just simply talking to people. But it's a discipline on its own, and a necessary training that is needed to work with councillors and general community members. It becomes difficult when you don't have this capacity to work. It's a skill and art that is required that needs to be respected and abided. It becomes easier when people gain this skill.

Mr V also highlighted the *need to build stronger participation networks with other stakeholders*, as this could potentially strengthen the CBWQM CoP. He stated that "collaboration with other stakeholders who see what is happening [success of the projects] because they see that something is happening attracts others". He therefore emphasised that there is a need to build a partnership between the public and the water authorities, as well as a need to include the old generation of Enviro Champs within projects as mentors to guide the new Enviro Champs. He commented, "their presence is of a great importance in terms of passing down the knowledge in respect of the work that has been done before to the new generation of Enviro Champs".

It is evident that there is a need for continued effort in strengthening partnerships between CBWQM organisations and municipal structures and with the communities where CBWQM projects are implemented. This ensures that CBWQM projects are more effective and could potentially ensure the sustainability of the practice in the long run. Furthermore, while some training is already being offered, and is *an enabling factor*, more training needs to be conducted with the Enviro Champs on the digital and technical tools such as the Field Survey and Geo ODK app as well as citizen science tools (shared repertoire) in order to strengthen their practice.

4.3.4 Analysis 4: How support for social learning in the COPS can potentially be extended

Here I again focus on the two scaling pathways that are of interest to this study: Scaling Pathway1 (policy, resources, job creation etc.) and Scaling Pathway 3 (capacity building). I identify insights into these as found in the interview data.

Local government support and partnerships*:* According to Mr V, there is a need for extended support from local government, with regard to funding CBWQM projects sustainably. This ensures that CBWQM projects are not short-lived and the impact of the projects is greater. Mr V further stated that building partnerships at various levels, especially politically, is essential to securing sustainable funding for CBWQM projects. Mr F supported this statement by highlighting the major role that municipalities need to play in supporting CBWQM projects: "I'm including municipal structures as well as sort of central government structures, which is the gaping hole". Mr T, supported this statement by commenting that "the local municipalities aren't engaging with community-based water quality monitoring as much as they should. So, they should engage more that's the first point." It is evident that there is an immediate need to strengthen relationships between policy, government structures, and municipalities. When these participation networks are strengthened, it diversifies the stakeholder base of these CBWQM CoPs, thus cultivating innovative thinking aimed at addressing constraining factors, the most pertinent being unsustainable funding. Ms B supported this statement by stating that "all partners should have a common understanding of working together within a genuine CoP".

Financial models for more sustainable funding*:* According to Ms B and Mr V, blended financial models to finance CBWQM initiatives have been worked as a solution to date, under the AEN programme to provide a solution to the unsustainable funding issue of CBWQM projects. A blended finance model means drawing in different sources of funding from different stakeholders to support the practice of CBWQM. This model can be further explored and supported to help upscale CBWQM. Mr V supported this statement stating that,

> So far I see it as the solution because what we have tried to implement before has not yielded any positive results. There is evidence that public private partnerships are effective, that it can work because in terms change can really come about when there is an integration of different sectors within terms of working a common goal.

It is evident that there is a need to extend support for CBWQM initiatives along Scaling Pathway1 and 3, as unsustainable funding and lack of training are the major constraining

factors of CBWQM practices. Methods such as blended finance models and multi-stakeholder partnerships explored through the AEN programme should be further supported to meet the demands of more training and short-term funding within CBWQM projects, as was also reported in Lotz-Sisitka et al. (2022) (see also Section 2.4.1).

4.4 Document analysis

The following section contains an analysis of documents that I identified as offering further insight into the research questions in the two case study sites (see Section 3.4.3, Table 3.3). As in the two previous sections, I again use the analytical framework to guide the analysis (see Table 3.4).

4.4.1 Analysis 1: Learning together in a Community of Practice (CoP)

As in the questionnaire and interview analysis, the shared domain remains poor water quality, and an interest in monitoring and managing this problem. The document analysis offers further insight into this shared domain. According to DM1 and DM2, a number of townships in South Africa are faced with the challenge of poor water infrastructure, due to the history of housing construction under the Apartheid era. The Mpophomeni area (Case Study 1) is a township located within the uMngeni Catchment, which faces a variety of environmental issues attributed to factors such as poor service delivery, defective and poorly maintained infrastructure. Some of the environmental issues noted in DM1 and DM2 as a result of the abovementioned contributing factors, include spilling manholes due to blocked sewage systems, which leak into nearby streams, as well as the illegal dumping of solid waste and water leaks. DM1 additionally attributed the worsening water quality of the Mpophomeni area water sources to the lack of education and awareness on infrastructure use by the community. Community members often dispose of foreign items such as diapers, clothing or litter into domestic toilets and manholes, which lead to the water pipes getting blocked, and ultimately surcharging manholes. The illegal dumping of solid waste is further exacerbated by cultural beliefs held within the Mpophomeni area, of how the river is seen as a cleansing mechanism, that washes away dirt, in this case solid waste. Thus, incorrect practices are often disregarded as harmful to water quality by the community. Additionally, the majority of dumpsites are located along the river.

According to DG3, the Mpophomeni Sanitation and Education Programme (MSEP) was a joint initiative established in 2011 by Duzi uMngeni Conservation Trust (DUCT) and

uMgungundlovu District Municipality (UMDM). Environmental champions, later known as Enviro Champs, came together to respond to these issues *using citizen science tools*. When the MSEP project ended, it was evident that more work needed to be done to increase awareness and educate the community on water pollution and how the uMngeni River system is impacted. This led to the UMDM partnering with DUCT in November 2015 using funding from Expanded Public Works Programme (EPWP). Within this phase, the project was named the Save Midmar project. The team of 20 Enviro Champs employed the following *tools to monitor and address sewage and solid waste pollution impacting the water quality* of three tributaries entering the Midmar Dam: door-to-door visits aimed at educating the community on what to throw down the toilet, the clarity tube to assess the water quality at the Howick waste water outflow and sewer monitoring through reporting sheets, to name a few. These tools and the daily meetings and training the team was involved in, formed a shared repertoire.

The water quality issues faced in Mpophomeni was the shared domain that led UMDM and organisations such as DUCT to come together and support the Enviro Champ work to address these issues.

DG2 highlighted how the MSU project faced *similar environmental issues* as the Mpophomeni area noted in DM1 and DM2. According to DG2, the Msunduzi area, namely the Imbali, Sobantu and Ashdown area in which this project is located, faces *challenges of waste management, water and sanitation*. In response to these issues the project had the key purpose of reducing surcharging manholes, reporting neglected manholes that have not been fixed or maintained due to inaccessibility attributed to plantation overgrowth and to educate and raise awareness to communities and schools about waste, water and sanitation.

According to DM2 and DG1, the Mpophomeni Enviro Champs used *a variety of tools* to collect and generate data. These range from citizen science tools such as miniSASS to digital apps such as the Field Survey app. The Enviro Champs were encouraged to share this information onto public access websites such as miniSASS and Google Earth which portrayed the successes and the challenges of their work. These tools help the Enviro Champs generate information on water quality more effectively which is made available to the general public through platforms such as the Field Survey app. These tools form part of the shared practice of the Mpophomeni Enviro Champs which they use to address water quality issues within their community. These tools also help them engage with a variety of role players which include community members

and water authorities. The sewer monitors working within the MSU project as outlined in DG2 also used the Field Survey app to report sewer leaks within their areas.

DM2 outlined how the Mpophomeni Enviro Champs learn together through their daily activities, including *weekly meetings* held on a Tuesday and Saturday. During these meetings, each member gives feedback on their work tasks, raises any issues, plans for the week ahead and reviews the data collected. These meetings provide constant interaction and strengthen the relationship between the Enviro Champs. It also is a support mechanism as they are able to learn and help each other with regard to any challenges they may be facing. The team also learnt together through attending meetings with the wider community particularly, hosted by local government, in which they could share the work they were doing in the project. In these meetings the Enviro Champs were also able to learn about issues faced by the wider community.

It is evident that the Enviro Champs learn together through a variety of platforms including training, weekly attendance of external and internal meetings in which knowledge is shared and partnerships are strengthened.

4.4.2 Analysis 2: Outcomes of social learning within the CoP

DG2 reported that the sewer monitors working within the MSU project highlighted how the project not only transformed the way they interact with the environment, but how the project had an impact on the community too. One of the sewers monitors in the Sobantu area (DG2) stated how initially being a sewer monitor was just a job to him which he used to make ends meets, but over time his *understanding and passion for the environment* grew. He now prides himself for being part of a project that brings *environmental solutions* to the challenges faced within his community. He noted how the training through the project has contributed to his *understanding of the importance of water*.

Another sewer monitor working within the MSU project in iMbali (DG2) commented how working within the project helped him gain a sense of *ownership and responsibility for the environment*. He stated that, even after working hours, he would still intervene and reprimand someone who threw waste into the river. He would further use the opportunity to educate them about the impact of their actions. It is evident that the sewer monitors have transformed the way they interact with the environment as well as their perspective towards it, which is what propels them to act against harmful actions towards the environment as mentioned above.

4.4.3 Analysis 3: Support structures/factors that enable or constrain social learning

Enabling support*:* D2 indicated that some of the enabling factors of social learning within the Mpophomeni Enviro Champs project are the support mechanisms offered through capacity building and non-formal training programmes the enviro champs implemented to educate and raise awareness of water quality issues to the community. These initiatives were supported externally by WESSA, an accredited training organisation. Through these initiatives the team engaged the community in the process of addressing environmental issues, and were also able to gain a deeper understanding and perspective of the issues faced by the community. Additionally, the support from WESSA assisted the team to enhance their non-formal initiatives and gain confidence in the work they do.

According to DM2 in Mpophomeni, the *relationships* the Enviro Champs had with organisations such as WESSA, WWF-SA and Water Explorers guaranteed their participation in national events that would support the work they were doing. These *links* have also provided a platform for the Enviro Champs to showcase their work publicly, which served to upscale and demonstrate the impact of their work. This *publicity and communication* increases the potential of the project to be funded further, thus ensuring the continued operation and interaction of members within the CBWQM CoP, necessary for social learning to occur.

The *collaboration of governmental, non-governmental organisations and educational institutions*, such as the partnership between DUCT and UMDM to implement this project, has proven to be another enabling factor of social learning within DM2. This has led to richer *research outputs* for researchers within the University of KwaZulu-Natal (UKZN) and Rhodes University who are interested as well as involved in the Enviro Champ work. It has moreover helped all partners to recognise they have joint responsibility towards the catchment. This *multi-level support* of CBWQM work potentially provides the platform for the work to continue beyond the programme, through funding opportunities from an international and national level. This would help ensure that projects continue beyond the short-term funding cycles of CBWQM projects.

Political support via policy has proven to be both an enabling and constraining factor for CBWQM work in DM2. According to the national policy, particularly the National Environmental Management Act (NEMA) of 1998, there is equal opportunity for all citizens to participate in environmental management decisions, thus providing an enabling factor for CBWQM work to occur, a sentiment also included in the IWQM policy (discussed in

Chapter 2). This national level support opens up opportunity for citizens to be engaged in CBWQM work and potentially to be funded. Additionally, industries have a *corporate social responsibility* according to legislation to ensure that their actions are not harmful to the environment but overall benefit the environment and the community they are operating in. This political support enables social learning, as CBWQM projects have a greater advantage of continuing beyond the project cycle.

Constraints to support for social learning: However, as reported in D2, a political constraint to social learning, is that there may not be compliance from the responsible authorities such as municipalities and governance structures with regard to national policy enforcement outlined above. This may be because they fear their shortfalls being exposed. Additionally, funding from business is short-lived as most corporates do not fully identify with the shared benefits of CBWQM projects.

From the document analysis, it is evident that both policy support and multi-level collaboration and partnerships influence the potential of funding being secured for CBWQM projects which ensures the continuation of the work and the social learning. Without both these enabling factors, CBWQM projects could be truncated and suffer from discontinuities which also affects the social learning potential, as discussed above and also reflected in the questionnaire and interview data.

4.4.4 Analysis 4: How support for social learning in the CoPs can potentially be extended

Funding, partnerships and capacity development*:* DG1 indicates that support for CBWQM work could potentially be extended through adopting *a multi stakeholder approach* and structure, thus potentially opening an opportunity for diverse funding for CBWQM work. According to DG 1, this support means that CBWQM projects do not have to rely solely on support from one stakeholder, which is commonly the government. Additionally, DG1 highlighted the need for *green skills learning pathways* which can further support capacity building training for Enviro Champs, as well as forming *partnerships with training institutions* that can provide *long-term intensive training* for Enviro Champs.

4.5 Conclusion

The data sourced from the interviews, questionnaires and document analysis clearly identify how inconsistent funding, lack of consistent training and the lack of policy support are amongst the most constraining factors for CBWQM CoPs, and how these factors have direct implications on the social learning process.

Despite these constraints, it is evident that social learning *is* occurring with the CBWQM CoPs, – in Case Study 1 this occurred though weekly meetings in which Enviro Champs shared their challenges and highlights of the week, as well as through the specific technical and social training in which they were further capacitated to do Enviro Champ work. From a funding model approach, it appears that multi-stakeholder partnerships and a blended funding model have potential to address the systemic problems identified with regard to funding. In conducting the analysis, I found the different insights gained from the different data sources offered a fuller view of the whole, and in the next chapter I relate all the data sources to each other to consolidate the findings. The next chapter will therefore discuss the findings from Chapter 4 in a way that offers a synthesis of the data, and through this I offer consolidated insights into the potential of social learning to upscale CBWQM.

Chapter 5: Discussion: Key insights into and ways of strengthening social learning in CBWQM Communities of Practice

5.1 Introduction

In this final chapter I draw from the findings presented in Chapter 4 to synthesise and consolidate the major insights of the study. I do this by providing a detailed account of the relationship of these findings to the research questions and main objectives, theoretical frameworks used and previous work of similar research contexts and themes (WRC action based research). In this chapter I also share the implications of these findings for future CBWQM work (recommendations) and further argue these claims and promote the potential of social learning to upscale CBWQM in South Africa, particularly at a local level, along Scaling Pathway 1 (Political economy and support) and 3 (Capacity building). To achieve this, eight analytical statements were formulated, which helped me to structure an in-depth discussion in order to provide a broader understanding of the findings. Lastly, in this chapter I provide recommendations to further investigate areas of this research that were not fully covered and that may have further potential to expand research in context within the field of community based water quality management.

5.2 Summary of study

As shared in previous chapters, this study was conducted as a qualitative study focussing on two case studies of CBWQM. It also drew on 14 questionnaires which were conducted in the wider project on scaling of CBWQM in which this study is located. For convenience and the re-establishment of important facets of this study, I reintroduce the aims and research questions here:

- The aim of this study was to:

  Investigate social learning in CBWQM communities of practice with emphasis on two cases in KwaZulu-Natal, and to identify what support is required for scaling of social learning in CBWQM communities of practice.

- Sub-questions/ specific objectives of the research are:
  - (i) How are social learning processes taking place in CBWQM communities of practice?
  - (ii) What are the outcomes of the social learning in CBWQM CoPs? and

(iii) What support is enabling the social learning in these communities of practice and how can this potentially enable scaling of the CBWQM outcomes and practices with the aim of further upscaling CBWQM work within local CoPs?

5.3 Synthesis and main findings

I now turn to a synthesis of the main findings of the study. These are presented using Analytical Statements. I refer to data presented in Chapter 4, and discuss the findings with the literature. I also offer recommendations where relevant based on the analysis and discussion.

5.3.1 Main findings related to social learning

5.3.1.1 Analysis statement 1: Commonly experienced issues create a shared domain (interest) and willingness for people to gather as a CoP and develop a shared practice to address the issue.

According to Eckert (2006), who is further supported by Lotz-Sisitka et al. (2010), a community of practice (CoP) refers to a group of people who share a particular interest on a specific topic (can be a concern or passion), who seek to understand the topic in depth by engaging regularly, as a result of sharing a particular interest or concern on a specific topic. They are a formed as a response to a joint interest. This is evident from the findings from the data found in all sources: questionnaires, interviews and documents (see Chapter 4). In particular, the data sources all reveal that commonly experienced issues related to poor environmental conditions and especially poor water quality have created a shared domain and willingness for people to gather as a CoP to address the issue in the two case study sites.

As discussed in Chapter 2, and according to Roberts (2006) and Wenger et al. (1998), CoPs are characterised by three factors, namely mutual engagement which refers to the constant interaction of individuals which creates relationships among them; a domain, which interests and gives individuals meaning; and a shared repertoire which is developed by the CoP over time, which refers to the common resources (tools, language, routines) used to respond to the shared domain.

The CBWQM initiatives investigated in this study both locally and in South Africa are characterised as CoPs as they have all three characteristics. In the context of this study, *the domain* being addressed is poor water quality as a result of two main contributing factors as explicitly highlighted in Table 4.3. These CoPs, interact on a daily basis to address water quality issues within communities. The main practice is water quality monitoring and related

environmental activities using citizen science tools such as miniSASS, velocity plank and clarity tube as well as through capacity building activities which are aimed at equipping them to engage in their domain, which includes engagement with communities and other partners such as municipalities. This forms part of their shared repertoire.

The questionnaire, interview and supporting data from the document analysis revealed a strong correlation of how commonly experienced (shared domain) water quality challenges by a community leads to the formation of community-based water quality management initiatives in an effort to address these issues. Several authors, as mentioned in Chapter 2, link the collaboration of a diverse range of stakeholders (academic, government, municipal and national government structures) to address a commonly shared concern as CBM, of which its functioning reflects a CoP (Bucklands-Nicks, 2016; Carlson & Cohen, 2018; Conrad & Daoust, 2008; Pollock and Whitelaw, 2005). In support of this statement, a study conducted by Kolbe (2014) on citizen science and water quality in the uMngeni Catchment states that a large number of communities within South Africa face common environmental issues, attributed to illegal dumping of solid waste and pollution of freshwater sources by leaking manholes (with raw sewage spilling into nearby water sources). The concerted effort emanating from the shared water quality challenges in many communities has resulted in a diverse array of CBWQM initiatives being formed in South Africa which range from civil society-led multi-stakeholder partnerships projects such as the Mpophomeni Enviro Champs, corporate social investment-led partnerships such as the Wise Ways Care and local government leadership supported projects, such as the MSU project (Lotz Sisitka et al., 2022). North America, Europe, Canada, New Zealand and Vietnam, were also identified by Carlson & Cohen (2018) as countries that have responded to the water quality challenges and failure of local governance to responsibly manage and monitor water quality through CBM. The study by Lotz-Sisitka et al. (2022) identified 60 such projects, of which I focussed on 14 via the questionnaire data and two via in-depth case studies.

These various CoPs face similar environmental issues attributed to poor service delivery, and poorly maintained infrastructure within many townships, which leads to issues such as illegal dumping of solid waste, water leaks and leaking manholes (Kolbe, 2014; Lotz-Sisitka et al., 2022). Several pieces of literature attribute poor water and sanitation service delivery experienced in a number of townships to remnant issues caused by the Apartheid era, which is now also coupled with municipal failures and which, according to the questionnaire, interview

and document data, is leading to initiatives to strengthen collaborative governance, support livelihoods and community education.

Literature argues that despite the great effort made through the development of water laws, that are founded on the "right of access to water", there has been limited tangible evidence of the impact of the effect of this legislation in terms of effective governance (Jegede & Shikwabane, 2021). This speaks to the CBWQM initiatives started by local citizens and organisations who respond to the ongoing water-related issues. This is direct evidence that community-led CBWQM is a response to the ineffectiveness of legislation and governmental structures to improving the water quality issues faced today. The CBWQM initiatives presented in Chapter 4 (Table 4.1) are direct evidence of the civil society response to water quality issues.

To further support my above claim, in Case Study 1, Ms N and Ms S identified leaking manholes and illegal dumpsites as the main issue attributing to worsening water quality of water sources within the Mpophomeni area. This is further supported in the Mpophomeni Enviro Champs evaluation report (DM2) which recognised illegal dumping of solid waste and leaking manholes as the most common challenges faced within the area. DM1 additionally identified poor service delivery, malfunctioning sanitation infrastructure and a lack of community education and awareness as contributing factors to worsening water quality of water sources in the area. The most substantive contributing factor to worsening water quality in South Africa, and more specifically in Mpophomeni, according to Kolbe (2014) is the raw sewage that flows into freshwater sources as a result of leaking manholes. This is supported by the interview data findings sourced from Enviro Champs who worked as part of the Mpophomeni Enviro Champs project (see Section 4.3) presented in Chapter 4. The interview data revealed that of the nine participants interviewed, four of them identified leaking sewers as the most contributive factor to worsening water quality. This is mainly due to the poorly maintained infrastructure within the Mpophomeni area, which leads to blocked pipes which results in overflowing manholes and toxic waste water flowing into rivers (Kolbe, 2014).

It is important to note that the Mpophomeni Enviro Champs project initially emanated from funding provided by the uMgungundlovu District Municipality (UMDM) with support from DUCT, previously known as the Sanitation Education Programme. Later, additional funding was secured through the WWF-SA Nedbank Green Trust and Expanded Public Works Programme (EPWP) which provided employment for over 20 Enviro Champs (Lotz-Sisitka et al., 2022). This multi-level support (government, non-governmental organisations and the

community) of a civil society-led project further supports the above claim of partnerships being formed amongst stakeholders sharing a common problem, and coming together to address the issue through a shared practice.

This also indicates how a shared interest can attract multi-level support and funding to form a CoP, in the effort to address environmental issues. According to Ward (2016), the collaboration of governmental and non-governmental organisations in DM2 who share a vested interest in improving the water quality of areas within the uMngeni Catchment leads to collective action and shared accountability in responding to water quality challenges. For example, DUCT's objective is to champion the environmental health of uMngeni and uMsunduzi Rivers, and additionally partner with entities that share the same vision, while UMDM has the responsibility of collecting solid waste, which ends up in rivers if unattended to. Ward (2016, p. 15) commented "this recognition that the networked partners share a collective responsibility within the catchment, rather than separate groups seeking to bring about change in the 'other', has been a powerful enabling factor".

Another example of a common issue leading to collective action is the Wise Wayz Water Care (WWWC) in DG 1, in which CBWQM community groups within the Folweni and Izimbokodeni areas engaged in clean-ups and education programmes, initiated by the Department of Water and Sanitation (DWS). Illegal dumping of solid waste and poorly maintained sewage infrastructure leading to leaking manholes, attributed to worsening water quality and flooding of local water sources within the two areas (Lotz-Sisitka et al., 2022). This attracted more than 200 community members to partake in clean-ups as well as garnered support from local industries, namely AECI, ImproChem and the Acacia Operations Services through the AECI Community Education and Development Trust, who supported the CBWQM activities of the community groups. The project was also supported through EPWP funding between 2015 to 2016. The WWWC project is a practical example of corporate and government support working together to address a common issue of deteriorating water quality as a result of illegal dumping of solid waste and leaking manholes. This concerted effort to support community groups is due to the direct benefit industries located downstream from the communities get, as the likelihood is decreased of floods and waterborne diseases they both could be affected by (Lotz-Sisitka et al., 2022). According to Lotz-Sisitka et al. (2021), funding from the government came to an end as soon as private funding came in. Lotz-Sisitka et al. (2010) argued that the establishment of CoPs to address a particular issue within a domain does not guarantee its effectiveness. Roberts (2006) agreed with this statement stressing that "CoP

cannot be formed" (p. 625); instead, the natural formation of a CoP can only be supported and further developed. According to Lotz-Sisitka et al. (2010), there needs to be further support for a CoP to operate effectively, in order to strengthen and support it. Wenger's structural model is a useful tool that can be used to support and increase effectiveness of CBWQM CoPs, as will be discussed further below.

Another key feature identified across the data sources is shared tools that are used in capacity building in support of repertoire development, the shared domain and social learning. DG1 highlighted a variety of case studies similar to the WWWC and Mpophomeni Enviro Champs project, such as the Khulumani Water for Dignity and the MSU projects which both attracted support from stakeholders such as government and academic institutions and non-profit organisations to address water quality issues (see Table 4.1) using citizen engagement and tools. The findings of the questionnaire data (Section 4.2) clearly indicated that the CBWQM projects are active CoPs, as they share common water quality issues ascribed to illegal dumping and leaking to address these issues within each project, namely the employment of citizen science tools such as MiniSASS and community engagement in the form of educational awareness of water quality and sanitation issues. According to EC_1 (within Case Study 2), door-to-door education to raise solid waste and sanitation issues with the Sobantu community and the use of MiniSASS were among the tools which formed their shared practice used to address water quality challenges within the Baynespruit project.

Multiple stakeholders are also an important dynamic in the CBWQM CoPs that influences learning in the shared domain. An important finding to note from the abovementioned examples of CBWQM initiatives and across the data sources shared in Chapter 4, is the ability of an environmental concern as shared domain to attract a diverse range of stakeholders who are directly and indirectly affected by poor water quality. The Makana Regional Centre of Expertise (RCE) paper by Lotz-Sisitka et al. (2010) offers a practical example of how individuals from diverse backgrounds can be brought together by a common interest to share ideas and come up with solutions to address a commonly shared issue. This is exactly what can be observed in the CBWQM CoPs above, and as shown in Figure 2.3, these CoP members come together along the lines of O'Donoghue's T-model (Figure 2.1) and think, talk, take action, tune in and engage in field-based (enviro monitoring activities) together around a shared matter of concern.

From the study data shared in Chapter 4, it is evident that commonly shared issues attract a diverse stakeholder group whose participation in CBWQM practices is dependent on the level of impact of water quality issues faced in the area on them. Although this diverse stakeholder base attracts government and corporate support, according to Lotz-Sisitka et al. (2022), of which the WWC project is a good example, there is still unsustainability in terms of funding, as government funding cycles are still short-term and tend to cut off as soon as other forms of funding become available. The issues are of major concern to communities and carry less support from government and business stakeholders, as was also shown in the data in Chapter 4, which has also led to the difficulties in sustaining the shared domain, or at least in extending the shared domain to be more substantively inclusive of municipalities and business partners.

> ***Recommendation:*** As can be seen from the study data, there is therefore *still a need to develop a stronger shared domain for CBWQM work which is more inclusive of sustained municipal and business sector participation*. This can be done by factoring in CBWQM work into government and business partner budgets and making the benefits of this shared practice more visible to them, at all levels as suggested in the WRC final report by Lotz-Sisitka et al. (2022). This is particularly important at the local (municipal level), as the lack of municipal engagement and support was identified as one of the biggest constraints to CBWQM work. Stronger participation of municipalities and business partners in the CoPs can potentially also ensure more sustainable funding periods for CBWQM work, and a sustainable political economy to further upscale and support this work (Lotz-Sisitka et al., 2022).

5.3.1.2 Analysis statement 2: Citizen science tools, communication (WhatsApp) and engagement platforms create a shared repertoire (way of doing this) through which learning takes place

Another key finding in relation to the social learning in CBWQM CoPs as revealed by all data sources in Chapter 4, was linked to shared CS tools, communication and engagement platforms and their use. According to Wenger (1998, p. 83), "the repertoire of a community of practice includes routines, words, tools, ways of doing things, stories, gestures, symbols, genres, actions, or concepts that the community has produced or adopted in the course of its existence and which have become part of its practice". According to Lotz-Sisitka et al. (2010), Paechter and Marguerite (2021) and Roberts (2006), the shared repertoire of a CoP is created through constant interaction of individuals within the CoP, who create meaning for the work that they do, by developing resources which helps CoP members become effective in their domain.

According to the data presented in Chapter 4, it can be concluded as outlined in Table 4.3, that the use of apps such as Geo ODK and the Field Survey app to monitor and record water quality pollutants and store water quality data, use of citizen science tools (e.g. MiniSASS, velocity tube etc.) and tools for community engagement and awareness such as door-to-door education, form part of the shared repertoire of the CBWQM CoPs, particularly those being investigated in this study (Case Studies 1 and 2). However, the study by Lotz-Sisitka et al. (2022) showed that this is a strong common feature across the CBWQM projects in South Africa. This may also be because the shared tools have been made available as open access, shared resources to the environmental education and water management communities in South Africa through Share-Net and more recently through partners such as GroundTruth and DUCT (Lotz-Sisitka et al., 2022). With these, the CoPs have also created their own routines, which forms part of their shared repertoire. Ms Nd, in Case Study 2, supported this statement by noting,

> We used CS tools to carry out bio monitoring activities. We did miniSASS to measure E. coli, did velocity plank to measure seed of river, used a lot of tools. These tools helped us determine the overall health of the river. We also used WhatsApp to communicate what we are doing and give a picture of what we have done, and if anyone needs help we communicated this on the group. We also used the Field survey app to record illegal dumpsites, open sewers and storm water drainages that were blocked by litter … We did door-to-door education where we raised awareness in the community of why we should keep our water clean. We also educated the community on the impact of their activities on the rivers.

Within both case studies, an important finding was that individuals within the CoP engaged on a weekly basis which involved applying citizen science tools to monitor water quality issues. Once a week they met for a 'toolbox talk' in which they discussed the highlights and challenges of the week. Ms N from Case Study 1 further stated, in addition to the toolbox talk, the team of Enviro Champs attended informal training sessions every Tuesday, in which they discussed issues with the Field Survey app. These training sessions were conducted by Mr L, who was one of the first generation of Enviro Champs.

Within this environment, the Enviro Champs (CoP members) were able to learn from each other and share their difficulties on using the tools and the Field Survey app, in order to get solutions and enhance their experience of it. It is within this constant interaction of CoP

members that learning takes place. This reflects Reed et al.'s (2006) argument that learning occurs within social networks in which individuals are able to influence one another's viewpoints through sharing of information. I would argue in support of this by suggesting that the CBWQM CoPs, highlighted above, referred to as Case Studies 1 and 2 throughout this study, are characterised as social networks in which individuals interact regularly with each other on a daily basis to strengthen their shared repertoire to respond to their shared domain, which is a water quality issue.

The CBWQM CoPs, as shared in Chapter 4, and as outlined above, tend to involve a diversity of stakeholders, which offers a particular type of multi-dimensional learning as diverse groups are exposed to each other's thoughts and approaches. A diverse stakeholder base compromising individuals sharing varying viewpoints, values, ideas, beliefs and backgrounds within the CBWQM CoPs, as presented in Chapter 4, can create a conducive environment for learning, in this case, social learning to occur. According to Wals (2007), social learning is the by-product of individuals engaging in discussions that seek to understand the foundation of contradicting views of individuals in an effort to find shared solutions. Wals (2007) argued that this is the type of interaction and environment which brings about change and collective action. Without contradicting views, learning is not likely to happen. Nevertheless, too much or too little conflict can also hinder learning. An example of a project with multi-dimensional stakeholder perspectives is the WWWC project previously mentioned, which had community, governmental and corporate support. According to Lotz-Sisitka et al. (2022), it is inevitable to have conflicts when a CoP has a diverse group of stakeholders, as they will have very different viewpoints. Within such a context, learning is bound to happen when engaging with these tensions, which occurred within the WWWC project with the end of funding support from the governmental sector after corporate funding became available (ibid.).

The study data in Chapter 4 also reveals different types of platforms for learning, both formal and informal. As revealed in Chapter 4, learning occurred both informally and formally within CBWQM CoPs (Case Studies 1 and 2). In Case Study 1, the Mpophomeni Enviro Champs engaged in both formal (accredited) training provided by accredited institutions such as WESSA, as well as through GroundTruth who trained them on the use of different citizen science tools. A variety of other more informal exchange-based learning opportunities were offered to the Enviro Champs through organisations they had an existing relationship with such as Water Explorers and the Midlands Meander Programme (Lotz-Sisitka et al., 2022; Ward, 2016). These learning opportunities provided an engagement platform for the Enviro Champs

to equip themselves with knowledge and skills to strengthen their shared repertoire as well as enhance their individual learning. Some of the other more informal engagement platforms and learning opportunities initiated by the Enviro Champs afforded them the opportunity to learn from the community's perspective, the challenges they faced and contributed personally to their lives. As reflected in Chapter 4, these non-formal training opportunities included enviro clubs, door-to-door visits and drama youth productions. The review of the Mpophomeni Enviro Champs by Ward (2016) supports the above statement with one of the Enviro Champs stating in the group interview conducted at that time that the training they had received had empowered them, giving with confidence to help their kids with homework, as their understanding of the environment had improved. As can be seen in Chapter 4, the CBWQM social learning processes also included a concern for children to learn more about water quality issues, which is also reflected in this statement.

Another Enviro Champ stated that the accredited training courses they received at WESSA helped them to find better job prospects, at uMngeni Water. This additionally opened up opportunities for them to attend and network at workshops. As mentioned previously by Wals (2007) and Reed et al. (2006), social learning occurs within social networks, through social interaction within a diverse stakeholder group. The abovementioned CBWQM CoPs provided a conducive environment for social learning to take place, and therefore, based on the data in this study, I suggest that social learning occurs via the diverse CBWQM CoPs engagement platforms such as formal and non-formal training and within their weekly meetings and practice-based activities such as through door-to-door education and bio and environmental monitoring activities, all of which have expanded their shared repertoire.

> ***Recommendation****:* Data in this study also, however, showed that there is a need to further explore online based engagement platforms for CBWQM work, as the currently used platforms such as the Field Survey app, still need to be improved in order to be applicable to the different contexts in which they are applied by the Enviro Champs. Further effort also needs to be made to develop and adapt citizen science tools and field-based apps to cater for the majority of the users of these tools, which is the African community. In this way, the tools can be potentially even more effective within the context they are used. The study data in Chapter 4 also referred to strengthening community engagement skills, as well as formal learning green skills learning pathways for CBWQM practitioners, especially youth which points to strengthening both the informal and formal learning platforms, as well as the tools.

5.3.1.3 Analysis statement 3: Membership (participation), responsibility allocation and community interest are important to the social learning

Data in Chapter 4, across the questionnaire, interview and document analysis showed that membership and participation in the CBWQM communities of practice was important for social learning, and especially community interest. The need for greater interest from municipalities was identified as a need for strengthening social learning as pointed to above. According to Reed et al. (2006), learning can only be characterised as social learning when the transformation in understanding of the environment, extends beyond the individual, and becomes evident in the surrounding CoP. Additionally, as mentioned earlier by Reed (2006), social learning occurs within an active CoP, in which there is constant interaction and exchange of information, for example, through communication via WhatsApp, formal or non-formal trainings or one-on-one communication.

For the CBWQM CoPs such as the Mpophomeni Enviro Champs project discussed in Chapter 4, activities which formed part of their shared repertoire and practice was the allocation of responsibility of monitoring particular water-related issues such as leaking sewers, water leaks and illegal dumpsites. According to Ward (2016), collective control and ownership of the activities of the project, by Enviro Champs alongside DUCT created a sense of boosted commitment and drive to bring about change through the work they do. An example of this was the Enviro Champs meetings which the team created as part of their shared repertoire, in which they engaged on a weekly basis to discuss and share the data collected and the challenges of the week. These regular 'toolbox talk' meetings provided a supportive and interactive platform in which the Enviro Champs could assist each other with coming up with solutions to challenges and plan for the week ahead.

Although this shared repertoire reflects the practices of the first generation of Mpophomeni Enviro Champs evaluated in 2016, it is still a practice continued within current CBWQM CoPs (Case Studies 1 and 2), operating under the AEN programme. Ms Nd, from the Baynespruit Enviro Champs project (Case Study 2) noted that,

> We met five days a week (Monday to Friday) in which we conducted our daily enviro monitoring and biomonitoring activities. On Monday where we shared on the challenges we faced during the week, in which we had a toolbox talk where we shared information that we found and identify challenges that we faced during the week.

Ms S also alluded to this continued practice by stating that, "we met every day in the morning and we had meetings on Tuesday and Monday. Monday, we discussed the week's workplan". From this study data, it seems that it is this constant interaction and engagement with their shared practice that creates an environment for social learning to occur, within the social network of a CBWQM CoP. According to Ward (2016), these meetings create a strong bond between the CoP members, as they develop relationships with one another as well as a deep-seated sense of ownership for the work they do. Wenger (1998, p. 73) stated that "membership in a CoP is therefore a matter of mutual engagement". Wenger referred to mutual engagement as the constant engagement of individuals within a CoP in their shared practice. This is what creates a sense of membership. I would argue that sense of ownership is what leads to membership within the CoP. According to Reed et al. (2006), the learning that is occurring within CBWQM CoPs, demonstrating a sense of ownership, mutual engagement and responsibility for their shared practice, is characterised as social learning.

Reed et al. (2006) stated that learning must diffuse form the individual to the community through an existing CoP and through mutual engagement to be considered social learning. Therefore, this statement corresponds with claim 5, which additionally emphasises that community interest is in fact important to social learning. Without community buy-in and interest in CBWQM initiatives, it becomes very difficult to engage and even implement some of the CBWQM activities in communities, as was also stated in the interviews reported in Chapter 4. This is due to a lack of relationship caused by constant interaction with community members. In order for social learning within CBWQM such as the Mpophomeni Enviro Champs to diffuse to wider society, there needs to be consistent interaction with the community through engagement platforms such as door-to-door or community-led events such as river walks and clean-ups. But this is usually inhibited by a lack of community buy-in from CBWQM initiatives, as was alluded to by Mr V who commented on the 'homework' that needs to be done before projects are set up (see Chapter 4). He was referring to the 'homework' needed to establish a welcoming environment amongst the communities for projects of this nature. He further drew attention to inter-generational learning and interaction as a form of mutual engagement when he stated,

> Communities are not the same so the motive that brings about transformation and change is varied. But what brings about that change is the groundwork that has been laid at the start in the communities that we work in. For example, in Imbali and Sobantu, the EC work and CBWQM project have become part of the culture of the

community and become ambassadors that lead by example for the new generation of AEN Enviro Champs within the AEN. The new generation of ECs learns from the original ones (pioneers). They also engage with them and there is a sort of mentorship and guidance from the pioneers who grew this EC work.

Ensuring buy-in from the community means that the CBWQM CoP will have further community support, which will enable cooperation form community members, thus ensuring any leaking sewers, water leaks and illegal dumping are reported to the Enviro Champs by the community.

According to Ward (2016), the 'uniform' (special T-shirt) that the Enviro Champs wear which distinguishes them from the community, forms a part of their shared practice. This creates a sense of belonging and identity for each Enviro Champ within their CoP. Wenger (1998) stated that the shared practice of a CoP constitutes both explicit and inexplicit activities such as gestures, symbols or concepts created or adapted by the CoP members. I would argue that the above practice of wearing a 'uniform' when engaging in their Enviro Champ work is an important aspect of the shared practice within CBWQM CoPs as alluded to by Ward (2016), as this forms part of their identity and gives them a sense of belonging. To support this statement, Wenger (1998) stated that there is a strong affiliation between identity and practice, as the experiences the CoP members engage in forms part of their identity (their identity is negotiated through their practice). This mutual engagement as in negotiated practice influences the identity of each CoP member, and defines their belonging. It is within this type of social network, as mentioned earlier by Reed et al. (2006), that social learning occurs.

> ***Recommendation****:* There is need to give attention to community participation, membership and identity formation in CBWQM CoPs to strengthen social learning potential. This study shows that there is need to do 'homework' to establish such a conducive environment in the community to negotiate acceptance and participation in the CBWQM practices, and also to involve different generations of Enviro Champs in the process i.e. an inter-generational learning process.

5.3.2 Main findings related to social learning outcomes

5.3.2.1 Analysis statement 4: Social learning in CoPs leads to taking initiative, changed understanding and practices as well as social diffusion to home and local community spheres

Another key finding from across the interviews and document analysis data sets reported in Chapter 4, is that the social learning in the CoPs was leading to real outcomes for participants in terms of new understandings of environmental issues and concerns, relationships with water and diverse stakeholders, and community needs. This learning was leading to participants taking further initiatives to share information and manage water, and to share their knowledge and learning into communities. According to Reed et al (2006), social learning is said to have taken place in an individual when there is evidential change in understanding. This change can be displayed through a change in one's actions, perception of the world or in the internalisation and recall of information learnt. Wals (2007) further supported this statement noting that social learning can take place across these three different levels, namely at the level of an individual, a group or amongst stakeholders belonging to a social network. Data in my study reported on in Chapter 4 shows that social learning in CBWQM CoPs, is a change in understanding and practices as alluded to by Wals and Reed above. This is evident within the interview data sourced from participants interviewed (see Tables 3.1 and 3.2) within the Mpophomeni and Baynespruit CBWQM CoPs, in which they highlighted how social learning has impacted their interaction and perception of the environment.

When asked if their understanding of the environment has changed as a result of engaging in activities within their CoP, Ms S (Case Study 1) commented

> My understanding on the environment changed a lot, I had minimum understanding of the environment. I didn't know about alien plants, CS tools and the existing aquatic invertebrates. It's possible to live in a green economy and world and not be reliant on things like electricity, you can use organic and ozone friendly things and live in the old way. You can use rain water for watering, washing, as well as drinking and cooking. You can also use grey water for watering. There also a lot of games one can put in place to educates kids about the environment.

Ms Nd (Case Study 2) also commented "I am planning to start a small garden, because this helps us get closer to nature and maybe over time it will grow bigger. We gain a lot from nature as people although we don't take care of it. This will help me stay connected to nature which is very important to us as people."

From both these statements, it is evident there has been a change in understanding of how Ms Nd and Ms S perceive the environment, as their attitudes and knowledge of the environment has been enhanced. This change in understanding has caused them to value the benefits sourced from the environment and have a positive outlook on what living sustainably looks like. Ms N also supported the above statement by sharing,

> Yes it has, especially the way I understood river health. I didn't realise how much impact human actions had on the environment. I didn't realise the importance of the environment and the way we create waste and pollute. I have tried to reduce these factors.

Both Ms N and Ms Nd have demonstrated initiatives: Ms Nd expressed interest in starting her own garden and Ms N vowed to making an effort to reduce her impact on the environment through changing harmful behaviour. This, therefore, as explicitly explained in Chapter 2 and by Wals (2007), is how social learning has taken place at an individual level in Ms Nd, Ms N and Ms S, but has not yet diffused into wider social contexts, although in Chapter 4 data from documents it appeared that members of CoPs were sharing their knowledge and understanding with others, including children in the communities.

5.3.2.2 Analysis statement 5: Constant engagement in the CoP is essential for enabling social learning in the CoP, this requires sustained resourcing.

As revealed in Chapter 4, and as also discussed above, constant engagement in CBWQM CoPs, occurs through the shared practice that the CoP members negotiate in order to engage in their domain. Some of the activities the CoP members (Enviro Champs) engage in as highlighted in Chapter 4, and by Ward (2016) and Lotz-Sisitka et al. (2022), include but are not limited to weekly meetings, formal and non-formal training, river walks and bio-monitoring and enviro-monitoring activities. This constant engagement in their shared practice to address water quality challenges in their community is what facilitates mutual engagement and strengthens relationships of the Enviro Champs with one another. Ward (2016, p. 30) supported this statement by noting the impact of Enviro Champs meetings in this comment, "this constant communication has built a strong group who are obviously very fond of each other and look out for each other". As noted above, Reed et al. (2006) emphasised that social learning occurs within social networks where there is constant engagement. It is also evident in this study, that the constant engagement of the Enviro Champs within their shared practice enables social learning to occur.

Constant engagement in the CoPs was also strengthened by the formal and non-formal training the Enviro Champs engaged in, as highlighted in analysis statement 2, particularly by the first group of the Mpophomeni Enviro Champs, as mentioned earlier. This is also noted in the Mpophomeni Enviro Champs evaluation by Ward (2016) who commented on how the training had empowered and given the Enviro Champs confidence in the form of knowledge and skills, which has diffused into their wider social network, that is family. Therefore, both formal and non-formal training within CBWQM facilitates constant interaction, which enables social learning to occur in social networks.

As mentioned repeatedly in the data in Chapter 4, there is still a huge challenge in finding sustainable funding for CBWQM initiatives, an issue evident in many CBWQM initiatives investigated in this study, as most of the funding provided is short term. This is alluded to by Mr F, who commented that,

> There is a need for sustainable funding for projects, not only once off. If the project is sustained the project is sustainable which helps to see the impact of the CBWQM projects. There needs to be support in all aspects, not only the financial aspect. All structures, especially government has a lot of influence on the projects initiated on the ground. The involvement of the government is going to be required.

Within all the CBWQM projects discussed in Chapter 4, and noted in Table 4.1, sustainable funding to support the functioning of the CoP is an ongoing issue. This was also noted in the final WRC report on CBWQM scaling by Lotz-Sisitka et al. (2022, p. 218) in the case analysis of the Mpophomeni Enviro Champs,

> Despite the strategic location of Mpophomeni, the support from local government and national NGOs, and the impact of the initiative, funding for this citizen-based water quality management has been an ongoing struggle. At the time of writing this review (2018), the Enviro Champs are operating without any external funding.

This reveals a significant challenge still being faced today in the political economy of this kind of work, despite the effort of trialling a blended finance model in the AEN programme and as also tested in the WWWC project. In order for CBWQM CoPs to continue functioning, a more sustainable political economy needs to be established for this work. From this study, it seems evident that social learning is enabled by the sustainable resourcing of CBWQM CoPs as sustainable funding ensures that the CBWQM CoPs continue operating.

Recommendation: Sustained resourcing is necessary for sustained engagement in the CoPs. As indicated in this study, this is often discussed in funding terms, but there is also recognition that alternative funding mechanisms, that are not monetary based, such as a value exchange approach should be explored and researched to support other elements of CBWQM CoPs. This can include the provision of formal and non-formal training by highly resourced structures such as the municipality and accredited training institutions such as WESSA, to continue to support the empowerment and capacitation of the Enviro Champs during dormant funding periods, until a more sustainable funding approach is found. The blended finance approach was also an initiative in the AEN to try to address the challenge of sustained support for the CoPs, and therefore also their social learning.

5.3.2.3 Analysis statement 6: Shared domain keeps people interested and engaged in the Social Learning CoP.

As indicated in Chapter 4 and above, the commitment of diverse stakeholders to a shared domain is critical for social learning to occur, and for it to be scaled. As shown above, this involves establishing a more sustainable political economy and increasing capacity building efforts. Given the ongoing challenges related to sustainable resourcing, there is much effort and interest in creating sustainable funding models for CBWQM work, as demonstrated in the case analysis of CBWQM CoPs in South Africa in the WRC scaling research project (Lotz-Sisitka et al., 2022). The AEN programme is an example of such an effort, which trials a blended finance model which has proved to be working so far. When asked if the private-public partnership (PPP) model could assist in the financial sustainability of CBWQM projects, Mr V stated,

> So far I see it as the solution because what we have tried to implement before has not yielded any positive results. There is evidence that PPP is effective, that it can work because in terms Change can really come about when there is an integration of different sectors within terms of working a common goal. Which moves us away from finger pointing, holding others accountable while we fold our hands. Instead it's about a collective sense of doing things whereby if one doesn't do well, this impacts one other system because in the true essence we are working together in the work that we do. It's a much better system of working when there all sectors involved know collectively what the issues are and what needs to be done to solve those issues, to address the continuing issue of deteriorating water quality within communities. I could be wrong, but so far there aren't any red flags I've noticed in this finance model.

Mr F, also supported this statement responding to the same question, by saying,

> If we want the public private partnership to succeed beyond a once off throwing a coin in the tin. We need this thing to be sustainable. So public private partnership, definitely the way to go. Government seems to be hungry for working examples. We've got a working example. But I see little chunks in it that could be improved.

***Recommendation*:** To strengthen social learning, there is need to get more stakeholders committed to the shared domain, and to support the sustainability of the CBWQM CoPs and through this, expand the social learning potential. From both the comments above, it is evident that the PPP approach has proven to be useful in addressing funding issues of CBWQM projects, but as noted by Lotz-Sisitka et al. (2022), more research and further testing needs to be done. This evident effort of finding sustainable solutions to fund CBWQM initiatives is evidence that a shared domain keeps individuals (private and public sector) interested in the CoP. In the study it was clear that this was vitally important for sustainable outcomes to be achieved through CBWQM as also reflected in the contributions of Mr V and F above.

5.3.3 Main findings related to support and scaling

5.3.3.1 Informal and formal training helps individuals participate more effectively in the CoP activities

As already mentioned in analysis statement 3 and 4, formal and non-formal training form part of the shared repertoire of CBWQM CoPs. This component is critical because it enables the Enviro Champs to engage in their shared practice more effectively, and thus also better enables them to expand or scale their practice. Ward (2016) and Lotz-Sisitka et al. (2022) highlighted how training led to the improved understanding within the Enviro Champs of the environmental issues faced within their community which in turn help them to capacitate the community with knowledge and skills to identify and local environmental problems. Ward (2016) also states how the training benefited the Enviro Champs on a personal level, as some training was accredited and provided opportunities for them to access better job prospects, as noted by Mr L, after he partook in accredited courses at WESSA.

As discussed in Chapter 4 and above, informal training and education initiatives led by the Enviro Champs, such as door-to-door visits, the Mpophomeni youth productions and the enviro clubs all served to capacitate the community to be more knowledgeable about the environmental issued faced within their community (Lotz-Sisitka et al., 2022), helping to scale

the practice into the communities. It is evident that formal and informal training form a critical part of the shared practice of CBWQM CoPs. Without this training aimed at capacitating the Enviro Champs to do their work, they are unable to operate effectively within their CoPs.

> ***Recommendation**:* More opportunities for training (both formal and non-formal) should be opened up within related stakeholders (that is, municipalities, water-related NGOs and training institutions), to capacitate the Enviro Champs for the work they do. There is also a need to expand the scope of the training as recommended by participants in Chapter 4 to include social aspects of training, as well as project management, fundraising and fund management skills, technical skills for water quality monitoring and pollution control, and community engagement skills. There was further an interest in formal learning for children in schools, as well as learning for livelihoods opportunities. These can be considered in further research to identify and construct green skills learning pathways, which can possibly lead to more long-term beneficial training for the Enviro Champs, and potentially increase their job prospects, career opportunities and exposure beyond CBWQM project periods and their immediate CoP activities.

5.3.3.2 Analysis statement 8/Claim 8: Not only funding, but strengthening of relationships among diverse stakeholders is needed to scale social learning and more adequately support

As indicated in the data in Chapter 4, the collaboration of diverse stakeholders to address water quality issues in communities is an important aspect which has proven to provide support in more than one way for most CBWQM initiatives in South Africa. These include funding support, which ensures that the CoPs operate for longer, and publicity of CBWQM work on a larger platform attributed to the relations of CBWQM initiatives to well-known key stakeholders, such as national NGOs. According to Lotz-Sisitka et al. (2022), collaboration of water related organisations, corporations and governmental structures has been a strong empowering factor for CBWQM work, as also noted by Ward (2016). Some examples of such collaborative work are case studies such as the Mpophomeni Enviro Champs which have already been discussed in detail in Chapter 4. The Mpophomeni Enviro Champs project has been a collaborative effort of DUCT, the community and UMDM, which are all characterised as structures which have a vested interest in improving the water quality in the uMngeni Catchment. According to Ward (2016), the acknowledgment of the common duty by the stakeholders involved in the Mpophomeni project has proven to be the most prevailing empowering factor in the support and continuation of CBWQM initiatives.

Recommendation: In order to scale social learning, especially because CBWQM is a multi-stakeholder practice that requires engagement at multi-levels, there is a need to strengthen and support the existing relationships between stakeholders but also to make sure that all stakeholders are contributing strongly. Political stakeholders, as well as municipalities, are key stakeholders that need to get involved. Further research can be conducted on this aspect of CoP formation, especially also drawing in local leadership of traditional leaders as was being explored in the WESSA Leadership Seminars. This may help to address other challenges such the inconsistent support and lack of sustainable funding for CBWQM work, which is the biggest constraint to upscaling CBWQM work.

5.4 Recommendations for further research

From the above and from the data shared in Chapter 4, there are a number of areas for further research that have been opened up by this study. These include:

* Further research into the shared domain, and how to get more stakeholders more engaged and involved, especially municipalities and business sector partners

* Further research into the content, and substance for creating longer term green skills learning pathways that strengthen social learning of individuals, but in ways that contribute to their social networks and communities via wider social learning. Of interest would be to consider the mix of informal and formal learning experiences in such a learning pathway as this has shown to be significant in this study.

* Further research into specific aspects of the capacity building such as how to better support the use of the citizen science tools such as Field Survey app

* Further research into the blend of social and technical skills in building the repertoire of a Community of Practice

* Further research into the sustainability options for an improved political economy that can better support ongoing learning and interaction in CBWQM work, as it is evident that within my research there was no solution to the ongoing funding issue for CBWQM work; instead my research further highlights the challenges that have been faced by many CBWQM initiatives due to inconsistent funding cycles and support.

5.5 Conclusion

In conclusion, the findings presented in this chapter are evidence of the social learning that occurs in CBWQM CoPs. The chapter also summarises the findings related to enabling and constraining factors related to support for social learning in CBWQM CoPs. It also offers insight into scaling via expanded capacity development, especially combining formal and informal types of learning, and a wider range of training options. Additionally, it offers insight into the ongoing issue of unsustainable funding which affects the functioning of the CBWQM CoPs and their social learning. As shown across the study, this impacts on training, the social interaction of CoP members and social learning. Therefore, in order to upscale CBWQM in South Africa, more funding needs to be allocated within budgets at a municipal and government level in order to ensure that projects are more sustainable, and this should be combined with extended training and research into longer term green skills learning pathways.

References

Abbaspour, S. (2011). Water quality in developing countries, south Asia, South Africa, water quality management and activities that cause water pollution. *International Proceedings of Chemical, Biological and Environmental Engineering (IPCBEE)*, *15*(94), e102.

About Jojo (2022). https://www.rainharvest.co.za/jojo-water-tanks-2/about-us/

Adom, R.K. & Simatele, M.D. (2022). November. The role of stakeholder engagement in sustainable water resource management in South Africa. *In Natural Resources Forum*, 46(4), 410-427. Oxford, UK: Blackwell Publishing Ltd. https://doi.org/10.1111/1477-8947.12264

Afroz, R., Masud, M. M., Akhtar, R., & Duasa, J. B. (2014). Water pollution: Challenges and future direction for water resource management policies in Malaysia. *Environment and Urbanization ASIA*, *5*(1), 63-81.

Ahmed, S., & Saba, I. (2018). Water pollution and its sources, effects and management: A case study of Delhi. *International Journal of Current Advanced Research, 7*(2), 10436-10442.

Aluwihare-Samaranayake, D. (2012). Ethics in qualitative research: A view of the participants' and researchers' world from a critical standpoint. *International Journal of Qualitative Methods*, *11*(2), 64-81.

Arden, J. (2016). Water for all? Developing a human right to water in national and international law. *International and Comparative Law Quarterly*, *65*(4), 771-789.

Aroh, K. (2018). Globalization, industralization and population growth the fundamental drivers of pollution in a given society (India). *SSRN Electronic Journal.* https://doi.org/10.1080/07900620701871718

Astalin, P. K. (2013). Qualitative research designs: A conceptual framework. *International Journal of Social Science & Interdisciplinary Research*, *2*(1), 118-124.

Baker-Eveleth, L. J., Chung, Y., Eveleth, D. M., & O'Neill, M. (2011). Developing a Community of Practice through Learning Climate, Leader Support, and Leader Interaction. *American Journal of Business Education*, *4*(2), 33-40.

Basson, M. (2011). *Water development in South Africa*. UN-Water International Conference, Zaragoza, Spain, 3-5 October 2011. https://www.un.org/waterforlifedecade/green_economy_2011/pdf/session_1_economic_instruments_south_africa.pdf

Bernedo Del Carpio, M., Alpizar, F., & Ferraro, P. J. (2021). Community-based monitoring to facilitate water management by local institutions in Costa Rica. *Proceedings of the National Academy of Sciences*, *118*(29), e2015177118.

Bertule, M., Glennie, P.D., Bjørnsen, P.K., Lloyd, G.J., Kjellén, M., Dalton, J., Rieu-Clarke, A.S., Romano, O., Tropp, H., Newton, J.T., & Harlin, J. (2018). *Monitoring water resources governance progress globally: Experiences from monitoring SDG Indicator 6.5.1 on integrated water resources management implementation.* Water. https://gwptoolbox.org/resource/monitoring-water-resources-governance-progress-globally-experiences-monitoring-sdg

Birt, L., Scott, S., Cavers, D., Campbell, C., & Walter, F. (2016). Member checking: A tool to enhance trustworthiness or merely a nod to validation? *Qualitative Health Research*, *26*(13), 1802-1811.

Biswas, A. K. (2005). An assessment of future global water issues. *International Journal of Water Resources Development*, *21*(2), 229-237.

Blackmore, C. (ed.) (2010). *Social learning systems and communities of practice*. Open University & Springer-Verlag. https://doi.org/10.1007/978-1-84996-133-2_11, _c

Bonney, R., Cooper, C. B., Dickinson, J., Kelling, S., Phillips, T., Rosenberg, K. V., & Shirk, J. (2009). Citizen science: A developing tool for expanding science knowledge and scientific literacy. *BioScience*, *59*(11), 977-984.

Bowen, G. A. (2009). Document analysis as a qualitative research method. *Qualitative Research Journal, 9*(2), 27-40. https://doi.org/10.3316/QRJ0902027

Boyd, L., Tompkins, R., Padayachee, D., Malete, O., & Heath, R. (2011). *Integrated Water Quality Management: A mindset change – Testing a refined conceptual model.* Water Research Commission Report No. TT, 501(11).

Buckland-Nicks, A., Castleden, H., & Conrad, C. (2016). Aligning community-based water monitoring program designs with goals for enhanced environmental management. *Journal of Science Communication*, *15*(3), A01.

Bwapwa, J. (2018). Review on main issues causing deterioration of water quality and water scarcity: Case study of South Africa. *Environmental Management and Sustainable Development*, *7*(3), 14-34.

Bwapwa, J. (2019). Analysis on industrial and domestic wastewater in South Africa as a water-scarce country. *International Journal of Applied Engineering Research, 14*(7), 1474-1483.

Carlson, T., & Cohen, A. (2018). Linking community-based monitoring to water policy: Perceptions of citizen scientists. *Journal of Environmental Management*, *219*, 168-177.

Chaudhry, F. N., & Malik, M. F. (2017). Factors affecting water pollution: A review. *Journal of Ecosystem and Ecography, 7*(225), 1-3.

Chowdhury, M. F. (2014). Interpretivism in aiding our understanding of the contemporary social world. *Open Journal of Philosophy, 4*(3). https://doi.org/10.4236/ojpp.2014.43047

Claassen, M. (2013). Integrated water resource management in South Africa. *International Journal of Water Governance*, *1*(3-4), 323-338.

Cole, M. J, Bailey, R. M, Cullis, J. D., & New, M. G. (2018). Water for sustainable development in the Berg Water Management Area, South Africa. *South African Journal of Science, 114*(3/4). http://dx.doi.org/10.17159/ sajs.2018/20170134

Conaty, F. (2021). Abduction as a methodological approach to case study research in management accounting – An illustrative case. *Accounting, Finance & Governance Review*, *27*(1), 21-35.

Conrad, C. T., & Daoust, T. (2007). Community-based monitoring frameworks: Increasing the effectiveness of environmental stewardship. *Environmental Management, 41*(3), 358-366. https://doi.org/10.1007/s00267-007-9042-x

Constitution of the Republic of South Africa. (1996). https://www.refworld.org/docid/3ae6b5de4.html

Cooley, H., Ajami, N., Ha, M. L., Srinivasan, V., Morrison, J., Donnelly, K., & Christian-Smith, J. (2014). Global water governance in the twenty-first century. In P. H. Gleick (Ed.), *The World's Water: The Biennial Report on Freshwater Resources* (pp. 1-18). Springer.

Cox, A. (2005). What are communities of practice? A comparative review of four seminal works. *Journal of Information Science*, *31*(6), 527-540. https://doi.org/10.1177/0165551505057016

Creswell, J. W. (2003). *Research design: Qualitative, quantitative, and mixed methods approaches* (2nd ed.). Sage.

Crowe, S., Cresswell, K., Robertson, A., Huby, G., Avery, A., & Sheikh, A. (2011). The case study approach. *BioMed Central (BMC)*, *11*(1), 100.

Cunha, D. G., Marques, J. F., Resende, J. C., Falco, P. B., Souza, C. M., & Loiselle, S. A. (2017). Citizen science participation in research in the environmental sciences: Key factors related to projects' success and longevity. *Anais da Academia Brasileira de Ciências*, *89*, 2229-2245.

Danielsen, F., Burgess, N. D., Jensen, P. M., & Pirhofer-Walzl, K. (2010). Environmental monitoring: The scale and speed of implementation varies according to the degree of peoples involvement. *Journal of Applied Ecology*, *47*(6), 1166-1168.

Department of Water and Sanitation. (2017). *Water quality management policies and strategies for South Africa. Report No. 4.1. Implementation Plan.* Water Resource Planning Systems Series, DWS Report No.: 000/00/21715/18. Pretoria: Department of Water and Sanitation.

Department of Water and Sanitation. (2019/2020). *Annual report.* https://www.gov.za/sites/default/files/gcis_document/202104/dws-annual-report-2019-20.pdf

Eckert, P. (2006). Communities of practice. *Encyclopedia of Language and Linguistics*, *2*(2006), 683-685.

Edokpayi, J. N., Enitan-Folami, A. M., Adeeyo, A. O., Durowoju, O. S., Jegede, A. O., & Odiyo, J. O. (2020). Recent trends and national policies for water provision and wastewater treatment in South Africa. In P. Singh, Y. Milshina, K. Tian, D. Gusalin &

J. P. Bassin (Eds.), *Water conservation and wastewater treatment in BRICS nations* (pp. 187-211). Elsevier.

Eitzel, M., Cappadonna, J., Santos-Lang, C., Duerr, R., West, S. E., Virapongse, A., Kyba, C.C., Bowser, A., Cooper, C.B., Sforzi, A., Metcalfe, A.N., Harris, E.S., Thiel, M., Haklay, M., Ponciano, L., Roche, J., Ceccaroni, L., Shlling, F.M., Dorler, D., Heigl, F., Kiessling,T.,Davis, B.Y., & Jiang, Q. (2017). Citizen science terminology matters: Exploring key terms. *Citizen science: Theory and practice, 2(1)*, 1-20. https://dx.doi.org/10.5334/cstp.96

Graham, P. M., & Taylor, J. (2018). *Development of citizen science water resource monitoring tools and communities of practice for South Africa, Africa, and the world*. Research report no. TT763/18, Water Research Commission, Pretoria.

Graham, P. M., Dickens, C. W., & Taylor, R. J. (2004). miniSASS – A novel technique for community participation in river health monitoring and management. *African Journal of Aquatic Science, 29*(1), 25-35.

Griffin, N. J., C. G. Palmer, & Scherman, P. A. (2014). *Critical analysis of environmental water quality in South Africa: Historic and current trends*. Technical Report No. 2184/1/14, Water Research Commission, Pretoria.

Halder, J. N., & Islam, M. N. (2015). Water pollution and its impact on the human health. *Journal of Environment and Human*, *2*(1), 36-46. https://doi.org/10.15764/EH.2015.01005

Hancock, B., Ockleford, E., & Windridge, K. (2001). *An introduction to qualitative research*. https://www.rds-yh.nihr.ac.uk/wp-content/uploads/2013/05/5_Introduction-to-qualitative-research-2009.pdf

Heale, R., & Forbes, D. (2013). Understanding triangulation in research. *Evidence-based Nursing*, *16*(4), 98-98.

Heleba, S. (2011). The right of access to sufficient water in South Africa: How far have we come? *Law, Democracy & Development, 15*. https://doi.org/10.4314/ldd.v15i1.10

Hove, J., D'Ambruoso, L., Mabetha, D., Van der Merwe, M., Byass, P., Kahn, K., & Twine, R. (2019). Water is life: Developing community participation for clean water in

rural South Africa. *British Medical Journal Global Health*, *4*(3), e001377. https://doi.org/10.1136/bmjgh-2018-001377

Hulbert, J. M., Turner, S. C., & Scott, S. L. (2016). Challenges and solutions to establishing and sustaining citizen science projects in South Africa. *South African Journal of Science, 115*(7/8). https://doi. org/10.17159/sajs.2019/584

Inyinbor Adejumoke, A. Adebesin Babatunde, O., Oluyori Abimbola, P., Adelani Akande Tabitha, A., Dada Adewumi, O., & Oreofe Toyin, A. (2018). Water pollution: Effects, prevention, and climatic impact. In M.Glavan (Ed.), *Water Challenges of an Urbanizing World* (pp. 33-47). InTech.

Jayaswal, K., Sahu, V., & Gurjar, B. R. (2018). Water pollution, human health and remediation. In S. Bhattacharya, A. Gupta, A. Gupta, A. Pandey (Eds.), *Water remediation. energy, environment, and sustainability*. Springer. https://doi.org/10.1007/978-981-10-7551-3_2

Jegede, A. O., & Shikwambane, P. (2021). Water 'apartheid'and the significance of human rights principles of affirmative action in South Africa. *Water*, *13*(8), 1104.

Jollymore, A., Haines, M. J., Satterfield, T., & Johnson, M. S. (2017). Citizen science for water quality monitoring: Data implications of citizen perspectives. *Journal of Environmental Management*, *200*, 456-467. https://doi.org/10.1016/j.jenvman.2017.05.083

Kanu, I., & Achi, O. K. (2011). Industrial effluents and their impact on water quality of receiving rivers in Nigeria. *Journal of Applied Technology in Environmental Sanitation*, *1*(1), 75-86.

Karodia, H., & Weston, D. (2001). South Africa's new water policy and law. *Research papers in Economics*. https://www.semanticscholar.org/paper/South-Africa%27s-new-water-policy-and-law-Karodia-Weston/f8153054fc4ec50f7f3da3da7a9f17b1b9117f81

Khatun, R. (2017). Water pollution: Causes, consequences, prevention method and role of WBPHED with special reference from Murshidabad District. *International Journal of Scientific and Research Publications*, *7*(8), 269-270. http://www.ijsrp.org/research-paper-0817.php?rp=P686703

Kjellstrom, T., Lodh, M., McMichael, T., Ranmuthugala, G., Shrestha, R., & Kingsland, S. (2006). Air and water pollution: Burden and strategies for control. *Disease Control Priorities in Developing Countries.* In D. T. Jamison, J. G. Breman, A. R. Measham, G. Alleyne, M. Cleason,D.B Evans, P. Jha, A. Mills & P. Musgrove (Eds.), *Disease control priorities in developing countries* (2nd ed.), Chapter 43. https://www.ncbi.nlm.nih.gov/books/NBK11728/

Koelsch, L. E. (2013). Reconceptualizing the member check interview. *International Journal of Qualitative Methods*, *12*(1), 168-179.

Kolbe, A.C. (2014). Citizen science and water quality in the Umgeni Catchment area, KwaZulu-Natal, South Africa. [Unpublished Masters thesis]. Queens University.

Kovács, G. & Spens, K.M. (2005). Abductive reasoning in logistics research. *International Journal of Physical Distribution & Logistics Management*, *35*(2), 132-144. https://doi.org/10.1108/09600030510590318

Kumar, M., Singh, G., Chaminda, T., Van Quan, P., & Kuroda, K. (2014). Emerging water quality problems in developing countries. *The Scientific World Journal.* https://doi.org/10.1155/2014/215848

Lambert, S., & Loiselle, C. (2007). Combining individual inteviews and focus groups to enhance data richness . *Journal of Advanced Nursing, 62*(2), 228-237.

Lepczyk, C. A, Boyle, O. D., & Vargo, T. L. V. (2020). *Handbook of citizen science in conservation and ecology*. University of California Press.

Lepheana, A. Russell, C. & , Taylor, J. (2021). Co-researching transformation within training processes in a post COVID-19 world. In I. Kulundu-Bolus, G. Chakona & H. Lotz-Sisitka (Eds.), *Stories of collective learning and care during a pandemic: Reflective research by practitioners, researchers and community-based organisers on the collective shifts and praxis needed to regenerate transformative futures*, (pp. 56- 82). Transforming Education for Sustainable Futures (TESF) and the Environmental Learning Research Centre (ELRC) (pp.59-81). https://doi.org/10.5281/zenodo.5704833

Lewin, S., Norman, R., Nannan, N., Thomas, E., & Bradshaw, D. (2007). Estimating the burden of disease attributable to unsafe water and lack of sanitation and hygiene in South Africa in 2000. *South African Medical Journal*, *97*(8), 755-762.

Lotz-Sisitka, H. (Ed.) (2012). *(Re)Views on social learning literature: A monograph for social learning researchers in natural resources management and environmental education.* Environmental Learning Research Centre, Rhodes University, Grahamstown.

Lotz-Sisitka, H., O' Donoghue, R. & Wilmot, D. (2010). The Makana Regional Centre of Expertise: Experiments in social learning. *Journal of Education for Sustainable Development, 4*(1). https://doi.org/10.1177/097340820900400114

Lotz-Sistika, H., Ward, M.,Taylor, J., Vallabh, P., Madiba, M., Graham, M., Louw, A., & Brownell, F. (2021). *Alignment, scaling and resourcing of citizen-based water quality monitoring initiatives*. Report K5/2854, Water Research Commission, Pretoria.

Madigele, P. K. (2017). South Africa's water regulatory and policy framework: A new institutional economic review. *Sustainable Water Resources Management, 4*(1), 129-141. https://doi.org/10.1007/s40899-017-0167-7

Masindi, V., & Duncker, L. (2016). *State of water and sanitation in South Africa*. Report, Council for Scientific and Industrial Research, Pretoria. https://doi.org/10.13140/RG.2.2.11466.77761

Miller-Rushing, A., Primack, R., & Bonney, R. (2012). The history of public participation in ecological research. *Frontiers in Ecology and the Environment*, *10*(6), 285-290. https://doi.org/10.1890/110278

Mohajan, H. K. (2017). Roles of communities of practice for the development of the society. *Journal of Economic Development, Environment and People*, *6*(3), 27-46.

Mohajan, H. K. (2018). Qualitative research methodology in social sciences and related subjects. *Journal of Economic Development, Environment and People*, *7*(1), 23-48.

Molobela, I. P., & Sinha, P. (2011). Management of water resources in South Africa: A review. *African Journal of Environmental Science and Technology*, *5*(12), 993-1002.

Montwedi, M., Munyaradzi, M., Pinoy, L., Dutta, A., Ikumi, D. S., Motoasca, E., & Van der Bruggen, B. (2021). Resource recovery from and management of wastewater in rural South Africa: Possibilities and practices. *Journal of Water Process Engineering*, 40, 101978. https://doi.org/10.1016/j.jwpe.2021.101978

Mugagga, F., & Nabaasa, B. B. (2016). The centrality of water resources to the realization of Sustainable Development Goals (SDG). A review of potentials and constraints on the African continent. *International Soil and Water Conservation Research*, *4*(3), 215-223.

Musingafi, M. C. C. (2014). Fresh water sources pollution: A human related threat to fresh water security in South Africa. *Journal of Public Policy and Governance, 1*(2), 72-81

Naiga, R. (2018). Conditions for successful community-based water management: perspectives from rural Uganda. *International Journal of Rural management*, *14*(2), 110-135. https://doi.org/10.1177/0973005218793245

Nare, L., Odiyo, J. O., Francis, J., & Potgieter, N. (2011). Framework for effective community participation in water quality management in Luvuvhu Catchment of South Africa. *Physics and Chemistry of the Earth, 36*(14-15), 1063-1070.

National Water Act. (1998). (Government Gazette, 19182, Notice 1091, 26 August 1998). Government Printer.

Newman, G., Wiggins, A., Crall, A., Graham, E., Newman, S., & Crowston, K. (2012). The future of citizen science: Emerging technologies and shifting paradigms. *Frontiers in Ecology and the Environment*, *10*(6), 298-304.

Nnadozie, R. C. (2011). Access to adequate water in post-apartheid South African provinces: An overview of numerical trends. *Water SA*, *37*(3), 339-348.

Odiyo, J. O., & Makungo, R. (2012). Water quality problems and management in rural areas of Limpopo Province, South Africa. *WIT Transactions on Ecology and the Environment*, *164*, 135-146.

Orb, A., Eisenhauer, L.D., & Wynaden, D. (2001). Ethics in qualitative research. *Journal of Nursing Scholarship, 33*(1), 93-6. https://doi.org/10.1111/j.1547-5069.2001.00093.x

Overdevest, C., & Stepenuck, K. (2004). Volunteer stream monitoring and local participation in natural resource issues. *Human Ecology Review, 11*, 177-185.

Paechter, C., & Marguerite, A. (2021). Communities of practice of transition: An analytical framework for studying change-focussed groups. *Sociological Research Online*, *26*(2), 360-376.

Pahl-Wostl, C., Mostert, E., & Tàbara, D. (2008). The growing importance of social learning in water resources management and sustainability science. *Ecology and Society, 13*(1), 24. https://doi.org/10.5751/ES-02352-130124

Pienaar, G. J., & E. van der Schyff. (2007). The reform of water rights in South Africa. *Law, Environment and Development Journal, 3(*2), 179. https://heinonline.org/HOL/P?h=hein.journals/leadjo3&i=207

Pienaar, G., & Van der Schyff, E. (2007). The reform of water rights in South Africa. *Law, Environment and Development Journal, 3*(2), 179-194. http://www.lead-journal.org/content/07179.pdf

Pollock, R. M., & Whitelaw, G. S. (2005). Community-based monitoring in support of local sustainability. *Local Environment*, *10*(3), 211-228.

Postel, S. L. (2000). Water and world population growth. *American Water Works Association*, *92*(4), 131-138. https://doi.org/10.1002/j.1551-8833.2000.tb08927.x

Potts, W. M., Mann-Lang, J. B., Mann, B. Q., Griffiths, C. L., Attwood, C. G., de Blocq, A. D., Elwen, S. H., Nel, R., Sink, K. J., & Thornycroft, R. (2021). South African marine citizen science – Benefits, challenges and future directions. *African Journal of Marine Science, 43*(3), 353-366. https://doi.org/10.2989/1814232X.2021.1960890

Pyrko, I., Dörfler, V., & Eden, C. (2017). Thinking together: What makes communities of practice work *Human relations*, *70*(4), 389-409. https://doi.org/10.1177/0018726716661040

Reed, M. S., Evely, A. C., Cundill, G., Fazey, I., Glass, J., Laing, A., Newig, J., Parrish, B., Prell, C., Raymond, C., & Stringer, L. C. (2010). What is social learning? *Ecology and Society, 15*(4). https://doi.org/10.5751/ES-03564-1504r01

Roberts, J. (2006). Limits to communities of practice. *Journal of Management Studies, 43*(3), 623-639. https://doi.org/10.1111/j.1467-6486.2006.00618.x

Rodela, R., Cundill, G., & Wals, A. E. J. (2012). A reflection on research design and methodologies used in the social learning literature. In H. Lotz-Sisitka (Ed.), *(Re)Views on social learning literature: A monograph for social learning researchers in natural resources management and environmental education* (pp. 31-38). Environmental Learning Research Centre, Rhodes University.

Romano, O., & Akhmouch, A. (2019). Water governance in cities: Current trends and future challenges. *Water*, *11*(3), 500. https://doi.org/10.3390/w11030500

Rossman, G. B., & Rallis, S. F. (2010). Everyday ethics: Reflections on practice. *International Journal of Qualitative Studies in Education*, *23*(4), 379-391. https://doi.org/10.1080/09518398.2010.492813

Roy, H. E., Pocock, M. J. O., Preston, C. D., Roy, D. B., Savage, J., Tweedle, J., & Robinson, L. D. (2012). *Understanding citizen science and environmental monitoring.* Final Report, UK Environmental Observation Framework. https://www.ceh.ac.uk/sites/default/files/citizensciencereview.pdf

Ryan, F., Coughlan, M., & Cronin, P. (2009). Interviewing in qualitative research: The one-to-one interview. *International Journal of Therapy and Rehabilitation, 16*(6), 309-314. https://doi.org/10.12968/ijtr.2009.16.6.42433

Ryan, G. (2018). Introduction to positivism, interpretivism and critical theory. *Nurse Researcher, 25*(4), 41-49.

Sánchez-Cardona, I., Sánchez-Lugo, J., & Vžlez-González, J. (2012). Exploring the potential of communities of practice for learning and collaboration in a higher education context. *Procedia – Social and Behavioral Sciences*, *46*, 1820-1825.

Soyapi, C. B. Water security and the right to water in Southern Africa: An overview. *Potchefstroom Electronic Law Journal, 20*(1), 1-26. http://dx.doi.org/10.17159/1727-3781/2017/v20n0a1650

Strauss, A., & Corbin, J. (1998). *Basics of qualitative research* (2nd ed.). Sage.

Stuckey, H. (2013). Three types of interviews: Qualitative research methods in social health. *Journal of Social Health and Diabetes*, *1*(2), 56-56.

Taylor, J. & Cenerizio, C. (2018). *An evaluation of the Msunduzi DUCT Pollution Monitoring. Maintenance and Community Education Project (from 2016-2018).* Report for UKZN/DUCT, Pietermaritzburg.

Thomas, D. R. (2006). A general inductive approach for analyzing qualitative evaluation data. *American Journal of Evaluation*, *27*(2), 237-246.

Tweedle, J. C., Robinson, L. D., Pocock, M. J. O. & Roy, H. E (2012). *Guide to citizen science: Developing, implementing and evaluating citizen science to study biodiversity and the environment in the UK*. Natural History Museum and NERC Centre for Ecology & Hydrology for UK-EOF.

United Nations. (2018). *Sustainable Development Goal 6 Synthesis Report 2018 on Water and Sanitation.* United Nations, New York.

Usali, N., & Ismail, M. H. (2010). Use of remote sensing and GIS in monitoring water quality. *Journal of Sustainable Development*, *3*(3), 228.

Vaismoradi, M., & Snelgrove, S. (2019). Theme in qualitative content analysis and thematic analysis. *Forum: Qualitative Social Research, 20*(3), 23. https://www.qualitative-research.net/index.php/fqs/article/view/3376/4470

Vallabh, P., Lotz-Sisitka, H., O'Donoghue, R., & Schudel, I. (2016). Mapping epistemic cultures and learning potential of participants in citizen science projects. *Conservation Biology, 30*(3), 540-549.

Van Vliet, M. T., Jones, E. R., Flörke, M., Franssen, W. H., Hanasaki, N., Wada, Y., & Yearsley, J. R. (2021). Global water scarcity including surface water quality and expansions of clean water technologies. *Environmental Research Letters*, *16*(2), 024020. https://doi.org/10.1088/1748-9326/abbfc3

Vann-Sander, S., Clifton, J., & Harvey, E. (2016). Can citizen science work? Perceptions of the role and utility of citizen science in a marine policy and management context. *Marine Policy*, *72*, 82-93. https://doi.org/10.1016/j.marpol.2016.06.026

Viman, O. V., Oroian, I., & Fleşeriu, A. (2010). Types of water pollution: Point source and nonpoint source. *Aquaculture, Aquarium, Conservation & Legislation*, *3*(5), 393-397.

Vincent, K., Steynor, A., Waagsaether, K., & Cull, T. (2018). Communities of practice: One size does not fit all. *Climate Services*, *11*, 72-77. https://doi.org/10.1016/j.cliser.2018.05.004

Viskovic, A. (2006). Becoming a tertiary teacher: Learning in communities of practice. *Higher Education Research & Development, 25*(4), 323-339. https://doi.org/10.1080/07294360600947285

Wals, A. E. J. (Ed.). (2007). *Social learning towards a sustainable world: Principles, perspectives, and praxis*. Wageningen Academic Publishers.

Wals, A. E. J., Van der Hoeven, N., & Blanken, H. (2009). *The acoustics of social learning: Designing learning processes that contribute to a more sustainable world*. Wageningen Academic Publishers.

Ward, M. (2016). *Review of the Enviro Champs Project in Mpophomeni*. WWF Nedbank Green Trust Project no.GT5416. GroundTruth, World Wildlife Fund for Nature and Nedbank Green Trust. http://www.c-s-v.co.za/wp-content/uploads/2020/04/GT5416-Enviro-Champs-Review-Report-November-2016-incl-Addendum.pdf

Weingart, P., & Meyer, C. (2021). Citizen science in South Africa: Rhetoric and reality. *Public Understanding of Science, 30*(5), 605-620.

Wenger, E. (1998). *Communities of practice: Learning, meaning and identity*. Cambridge University Press.

Wenger, E., McDermott, R., & Snyder, W. (2002). *Cultivating communities of practice : A guide to managing knowledge*. Harvard Business School Press.

Wilson, N. J., Mutter, E., Inkster, J., & Satterfield, T. (2018). Community-based monitoring as the practice of indigenous governance: A case study of Indigenous-led water quality monitoring in the Yukon River Basin. *Journal of Environmental Management*, *210*, 290-298. https://doi.org/10.1016/j.jenvman.2018.01.020

Yeasmin, S., & Rahman, K. F. (2012). Triangulation research method as the tool of social science research. *Bangladesh University of Professionals (BUP) Journal, 1*(1), 154-163.

Zainal, Z. (2007). Case study as a research method. *Jurnal Kemanusiaan*, *9*, 1-6.

Zhuwakinyu, M. (2012). *Water 2012: A review of South Africa's water sector*. Creamer Media's Water Report – May 2012. https://static.pmg.org.za/120904review.pdf

Appendices

Appendix A: Interview schedule

Interview schedule for data generation

The following interview questions are set differently according to the themes being studied.

1. **Investigating social learning in Communities of Practice (CoPs):**

Envirochamps:

1.1 What are some of the activities that you engage in when you meet?

1.2 What are some of the practices that you share as a group in your meetings (tools, language, app)?

1.3 In your understanding, what is the common problem you are addressing in your Community of Practice?

1.4 How often do you meet?

1.5 Has your understanding of the environment changed as a result of these meetings? if yes, how has your changing understanding of the environment influenced other people around you (family, friends, community)? – Has your perception of your surroundings changed

1.6 What are some of the lessons you've taken away from the CBWQM projects you've been involved in?

2. Addressing Scaling pathways 1 and 2

2.1 What would you say are some of the biggest gaps within the CBWQM projects that need to be addressed?

2.2 What type of trainings (accredited, non-accredited) do you think would be helpful for the envirochamps to address these gaps?

2.3 What support do you think the municipality and government can offer for CBWQM CoPs to improve the work of CBWQM projects (i.e. political support-from the municipality, government support)?

2.4 What support do you think the municipality and government can offer for CBWQM CoPs to improve the work of CBWQM projects (i.e. political support-from the municipality, government support)?

2.5 What political support do you think is needed further to support the CBWQM work?

Interview transcript example

Mr V's interview transcript (similar transcripts were done for Mr T, Mr L, Mr F, Ms S, Ms N, Ms Nd, Ms T and Ms B)

Interview with SV: Overall AEN DUCT project manager and project manager at DUCT

2. Addressing Scaling pathways 1 and 2

2.1 What would you say are some of the biggest gaps within the CBWQM projects that need to be addressed?

- challenges or major constraints- one of the major oes across initiatives and projects that align to CBWQM
- **-lack of sustainable funding** - CBWQM are good initiatives and well thought out but in most cases the length of time/duration of the project is usually a year or 2 years. Changes comes through the projects but it is not sustained but funding is not sustained and projected
- **Lack of community interest** in terms of where those CBWQM programmes are implemented. Homework needs to be done before projects are implemented in places. It can't be a copy and paste process. It becomes difficult to implement the project when the community/environment is not welcoming or conducive to that sort of CBWQM initiative.
- **Lack of training at all levels**, not only at community level. In terms of skills required of working with people/general community members. We take this social component for granted in terms of working with people because we think it's just simply talking to people. But it's a discipline on its own, and a necessary training that is needed to work with councillors, general community members. It becomes difficult whren you don't have this capacity to work. It's a skill and art that is required that needs to be respected and abided. It becomes easier when people gain this skill.

- **Example:** People do social work in the health department- it shows that in their job description one of the major things is to understand people and how they work- with us (DUCT) this is something we undermine when we try implement these programmes but it is extremely important if we are to gain success. Attached to this is community instability because we overlook this important component.
- **Lack of incentives** and return on work carried out, because thankless tasks are being done. The salaries in all honesty are too little, not enough to support one's basic needs. Exposure of the project to the community at large is important because success of CBWQM projects lies in the community
- Mindset, attitude and behavioural change of the community at large needs to be achieved and need to be one of the aspects that are worked on when CBWQM projects are implemented on the ground.
-

2.2 What type of trainings (accredited, non-accredited) do you think would be helpful for the envirochamps to address these gaps?

-It ranges, **people management training** is one of the key things to be able to handle all the complexities especially on the social side that come with engaging, conversing and dealing with people at a community level. It's being able to be trained in this regard as well as put this skill into practice (soft skills). What makes it difficult is that we work with people within CBWQM projects, and people are complex. It's sometimes difficult to be trained to deal or work with people as it's not easy to get this skill out of a book as communities differ from place to place so it won't be a copy and paste, but it's a technique that has been studied and put into practice , as there are schools of thought and practices that have been implemented and do work that help improve community engagement and people management.

- **Business management (long term training)-** to help individuals be independent, basic administration (e.g. filling up a form), Health and safety, and alien removal

What training has helped Sanele manage the CBWQM teams he works with?:

Educational background (formal studying and tertiary level education helps to a particular extent but more practice is gained through experience whilst carrying out the job at hand. Advice for others who would like to do Water resource management work is the importance of gaining project management experience with working on the ground with communities as they are the most important component that determine the success of CBWQM project. There is a need to have formal and informal training and community practice and engage with communities.

- What do you think has strengthened existing CBWQM teams at DUCT (what elements cause them to transform their interaction with the environment)?

  It ranges, as communities are not the same so the motive that brings about transformation and change is varied. But what brings about that change is the groundwork that has been laid at the start in the communities that we work in. For example, in Imbali and Sobantu, the EC work and CBWQM project have become part of the culture of the community and become ambassadors that lead by example for the new generation of AEN Envirochamps within the AEN. The new generation of EC's learns from the original ones(pioneers). They also engage with them and there is a sort of mentorship and guidance from the pioneers who gre0w this EC work.

  Power dynamics: what role can the mix of old generation (ones who laid the foundation) and new generation of EC's play in knowledge exchange?

  It's very key, the role of the old generation EC's. there is no contesting in terms of power dynamics between individuals

  - guidance and mentorship
  - respect of the work that has been done before and there is a sense of passing down of knowledge
  - They're presence is of a great NB in terms of passing down the knowledge

- There is no conflict in power dynamics I the engagements he has had in his teams, in the passing down of knowledge as well as roles and responsibilities
- There's a mutual respect between the old and new gen of EC's
- I see the involvement of the old gen of EC's as an NB aspect as they are ambassadors of the work that DUCT wants to do

Including the old gen of EC's (like Bab cele) in the planning process of CBWQM projects?

- They're involvement and presence is key

2.3 What support do you think the municipality and government can offer for CBWQM CoPs to improve the work of CBWQM projects (i.e. political support-from the municipality, government support)?

- In terms of local gov, is support in terms of financial strength and commitment form levels of government, for financial backing of projects that are happening at a community. These financial backing is tied in most cases by political backing as it needs to be approved politically. Partnerships and so forth comes about when there is support from key individuals from key individuals within gov and community structures. This makes it easier for projects to be carried out and to be a success in the community.

- Collaboration with other stakeholders who see what is happening (success of the projects) because they see that something is happening which attracts others

- The need for sustainable funding for projects, not only once off. If the project is sustained the project is sustainable which helps to see the impact of the CBWQM projects. There needs to be support in all aspects, not only the financial aspect. All structures, especially government has a lot of influence on the projects initiated on the ground. The involvement of the government is going to be required, whether it mean getting a particular permit or something else, there is still a critical need to get government support and involved, things helps things flow easily, regardless of the beaucracy that exists within governmental structures. If there is no communication or backing from the government this makes it hard for things to get done. If there is backing and support from the government things flow easily. They play a very key role within CBWQM projects, whether its bidding for the work that we do or getting sponsorship from various depts., us being sub-contractors for other work opportunities they are usually the. If we go into the private route they also come into the picture somewhere along the line.

What do you think Is the importance of public and private partnership?

An excellent example is the AEN project which came from DSI funding which showed purpose of what can be achieved within a short space of time when this blended funding model is implemented. Change can really come about when there is an integration of different sectors within terms of working a common goal. Which moves us away from finger pointing, holding others accountable while we fold our hands. Instead its about a collective sense of doing things whereby if one doesn't do well, this impacts one other systems because in the true essence we are working together in the work that we do. It's a much better system of working when there

sll sectors involved know collectively what the issues are and what needs to be done to solve those issues. We also know our weaknesses and we try solve these issues in time.

Do you think PPP could assist in the financial sustainability of CBWQM projects? – are they the solution

So far I see it as the solution because what we have tried to implement before has not yielded any positive results. There is evidence that PPP is effective, that it can work because In terms of financial systems and plans whether it be private organisations, gov or NGOs the landscape of finances change on a year to year basis due to factors such as budget cuts, policy and legislation others aren't able to commit to a longer funding periods on a programme level, By rhe systems that they have in place financially It is not possible to have longer funding periods. This financial landscape constantly changes, but if there's a collective sense of come with what you have, there is a sense of sustenance and ongoing of projects, it builds well with continuation even though I cannot contribute the same as I did previously this still builds well for continuation of projects. This is the picture we want, of continuation pf the projects. I could be wrong, but so far there aren't any red flags I've noticed in this finance model.

2.4 What role do you think the government, local industries and organizations can play to support the work of CBWQM practices in your community?

2.5 How does the project engage with policy at a local or national level?

Appendix B: Analytical memo

Analytical memo structures used to thematically organise data from sources

Guiding framework for qualitative data analysis:

Analytic Memo for Analysis 1: Social Learning in the Communities of Practice

	Domain (definition)	**Practices**	**Repertoire**	**Anything else?**
Case 1: Mpophomeni EC	MrJ: "XXXXX" MrA: "XXXX" DM1 DM2	Mr J: "XXXX" Mr A: "xxxxx"		
Case 2: Baynespruit EC	MsC: "XXXX' DB1" XXXX" DB3 "XXXX"			
General Amanzi Ethu	DG1 DG2			

Anaytical Memo for Analysis 2: OUTCOMES of the SL

	What happened?	What are the results?	Other / Anything else?
Case 1: M EC	Municipality responded … (D6)	XXXX	Lack of trust was visible which affected the outcomes (MrP)
Case 2: B EC			
General: AE			

Analytical Memo for Analysis 3: SUPPORT (enablers or contraints of SL)

	Nurturing support	Resources	Participation Networks	Other / Anything else?
Case 1: Mp EC		Smart phones were provided by XXXX	Linked into the wider AE network	
Case 2: B EC				
General: AE				

Analytical Memo for Analysis 4: Extending support for scaling pathway 1: policy, resources, job creation

	Policy	Resources	Job Creation	Other / Anything else?
Case 1: Mp EC	National policy to support our practice	Need more smart phones	Sustainable funding for jobs (R2)	
Case 2: ES EC				
General: ET				

Analytical Memo for Analysis 4: EXTENDING SUPPORT for scaling pathway 3: CAPACITY BUILDING

	Informal training	Formal training	Workplace training	Other / Anything else?
Case 1:				
Case 2:				
General: ET				

Example of the application of the analytical memo on the interview data for Analysis 1: Social Learning in the CoPs (the same was done for the questionnaire data)

Anaytical Memo for Analysis 1: Social Learning in the CoPs				
	Domain – shared enterprise/interest (definition)	**Practices -includes languages, tools, docs, images symbols,**	**Shared Repertoire : includes routines, words, stories, that**	**Anything else?**
Case Study 2 Baynespruit: C2 (EC1) : Aphelele Ndwonde	Ms Nd (Aphelele) EC1:	Ms Nd (Aphelele): We used CS tools to carry out bio monitoring activities We did miniSASS to measure E. coli, did velocity plank to measure seed of river, used a lot of tools. These tools helped us determine the overall health of the river. We also used WhatsApp to communicate what we are doing and give a picture of what we have done, and if anyone needs help we communicated this on the group. We also used the field survey app to record illegal dumpsites, open sewers and storm water drainages that were blocked by	Ms Nd (Aphelele): We did door to door education where we raised awareness in the community of why we should keep our water clean. We also educated the community on the impact of their activities on the rivers. Additionally, we engaged industries on their impacts of their water quality of the river and educated them on the impacts of industrial effluents on rivers.	Ms Nd (Aphelele): had planned work with industries to collaborate with them to help them not pollute the river (create awareness amongst them), but because the programme was short we were unable to do this. We also planned to restore illegal dumpsites into gardens
	common issue was [illegible] that they were unbearable for the surrounding residents. Even when they were reported they weren't fixed. I only realized when I entered the program that there we some areas such as Cinderella that were neglected . Some people burn and use the river as a laterine which contributes to increasing the Ecoli count	* water quality studies- using clarity tube, mini SASS, and velocity plank	We also reported illegal dumping sites as well as water leaks (water or tap leakage). We reported all of these issues we identified in the community on the FieldSurvey App. When we reported illegal dumpsites the Department of Waste was able to help us clear this dumpsite.	We reported all of these issues we identified in the community on the FieldSurvey App. When we reported illegal dumpsites the Department of Waste was able to help us clear this dumpsite. Although the dumpsites were cleared people still dump there, so we hope this +E4:E8changes in the future. We do create awareness in the community but they don't follow the rules or what we share with them that would build the community and protect the environment. Our aim with the project was to restore illegal dumpsites into
Case 1: Mpophomeni C1 (EC1)	Ms S: – [illegible] at were always leaking in the community and cleaning illegal dumpsites that people created.	-Water leaks: we fixed the water leaks in the community. We set daily goals of how much water we wanted to save and we will go into the community and fixed a leaks with this aim. We did the water leaks fixing on Wednesday	*We set daily goals of how much water we wanted to save and we will go into the community and fixed a leaks with this aim	

Appendix C: Ethical clearance letter

Approval letter of ethical clearance by the Education Faculity Research Ethics Committee

Rhodes University, Education Faculty
Research Ethics Committee
PO Box 94, Makhanda, 6140, South Africa
Tel: +27 (0) 46 603 8393
Fax: +27 (0) 46 603 8028
email: e.rosenberg@ru.ac.za

https://www.ru.ac.za/researchgateway/ethics/

17/08/2021

Nkosi Sithole

Education Department

g20s8385@campus.ru.ac.za

Dear Nkosi Sithole and Miss Nkosingithandile Sithole

Re: The potential of social learning to upscale the CBWQM process: A case study of the Mpophomeni EnviroChamps and the Wise Ways Care Project.

APPLICATION NUMBER: 2021-2816-6014

This letter confirms that your research ethics application has been reviewed and **APPROVED** by the Education Faculty Research Ethics Committee (EF-REC). Your permission letter(s) where applicable have been received and you are free to proceed with your study.

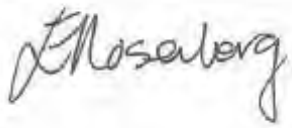
Approval is granted for 1 year. An annual progress report is required in order to renew approval for an additional period. You will receive an email notifying you when the progress report is due.

Should any substantive change(s) be made during the research process, that may have ethical implications, you should notify the Education Faculty REC Chair via email. This includes changes in investigators. The REC Chair will advise as to whether a new application is necessary.

Do keep this clearance letter secure and accessible throughout your study and after its completion. It will be needed when a thesis is examined and when publications are submitted to journals.

Please also submit a brief report to the REC Chair on the completion of the research. This can be done via email. The purpose of this report is to indicate whether the research was conducted successfully and whether any ethics-related matters arose that the committee should be aware of, in order to guide future studies. XXX

Sincerely,



Prof Eureta Rosenberg

Chair: Education Faculty Research Ethics Committee

Appendix D: Consent form to participate in study as interviewees

Ms N consent form (similar forms were completed and signed by Mr F, Mr S, Mr L, Mr T, Mr V, Ms B, Ms T, and Ms Nd)

RHODES UNIVERSITY
Where leaders learn

PARTICIPANT INFORMED CONSENT
INFORMED CONSENT DECLARATION
(Participant)

Project Title: The potential of Social learning to upscale the CBWQM process: A case study of the Mpophomeni and the Baynespruit Envirochamps.

Nkosingithandile Sithole from the Department of Education at Rhodes University has requested my permission to participate in the above-mentioned research project.

The nature and the purpose of the research project and of this informed consent declaration have been explained to me in a language that I understand.

I am aware that:

The aim of this study is to firstly investigate whether social learning is occurring in two CBWQM (CoPs) in KwaZulu-Natal, Pietermaritzburg, namely, the Baynespruit and the Mpophomeni envirochamps project; and secondly to investigate the support that is required to scale the social learning process in the two CoPs.

1. The Rhodes University has given ethical clearance to this research project *(Ethics Approval Number)* and I have seen/may request to see the clearance certificate by contacting Mr Siyanda Manqele (s.manqele@ru.ac.za).

2. By participating in this research project I will be contributing towards improving CBWQM practices, within KwaZulu-Natal. This is because this study has potential to improve scaling pathways for CBWQM projects, through the process of social learning. This could lead to the sustainability of CBWQM projects, which directly provides sustainable jobs for many individuals who can be absorbed as envirochamps in the program.

3. I will participate in the project by being part of the interview process that the researcher will be conducting; this involves responding to research related questions about the work that we do.

4. My participation is entirely voluntary and should I at any stage wish to withdraw from participating further, I may do so without any negative consequences.

5. I will not be compensated for participating in the research, but my out-of-pocket expenses will be reimbursed, i.e. travel costs to the research location will be covered should the participant live outside or far away from the research location.

6. The following risks are associated with my participation: I may feel at risk to share information, particularly negative information about the organization that I work with that I may be requested to share in the interview process. This risk will be avoided by being given the opportunity to decide whether I would like to participate in the study or not. The objective of the study will also be explained to me thoroughly so I can make an informed decision of whether I would like to be involved in the study or not.

7. The researcher (Nkosingithandile Sithole) intends publishing the research results in the form of a research paper. However, confidentiality and anonymity of records will be maintained for safety purposes and that my name and identity will not be revealed to anyone who has not been involved in the conducting of the research, unless upon request for verification purposes.

For safety purposes, and for avoidance of unauthorized distribution, it will be provided on request for verification when needed.

8. I will receive feedback in the form of a meeting and presentation regarding the results obtained during the study.

9. I agree/disagree to the Principal Investigator's request to take photographs, or videoing me as part of this research project

10. I agree/disagree to the Principal Investigator's use of voice recording of my comments and opinions during interviews

11. Any further questions that I might have concerning the research, or my participation will be answered by Nkosingithandile Sithole- cellphone number: 0823534099

12.

13. By signing this informed consent declaration, I am not waiving any legal claims, rights or remedies.

14. A copy of this informed consent declaration will be given to me, and the original will be kept on record.

I, [illegible] Nompumelelo Khanga, have read the above information / confirm that the above information has been explained to me in a language that

Appendix E: Online Review Tool example

DECLARATION OF INFORMED CONSENT

PROJECT TITLE Citizen Based Water Quality Monitoring (CBWQM) National Review

BEFORE STARTING WITH THE QUESTIONNAIRE, PLEASE READ THROUGH THIS PARTICIPANT INFORMED CONSENT FORM for ETHICS APPROVAL and COMPLETE THE QUESTIONS AT THE END.

INFORMED CONSENT DECLARATION - Project Title: Citizen Based Water Quality Monitoring (CBWQM) National Review

Distinguished Professor Heila Lotz-Sisitka from the Department of Education, together with the research team working on the project, from Rhodes University and other organisations have requested my permission to participate in the above-mentioned research project.

The nature and the purpose of the research project and of this informed consent declaration have been explained to me in a language that I understand.

I am aware that:

1. The purpose of the research project is to understand how CBWQM projects align, can be scaled and better resourced to enhance CBWQM within the Department of Water and Sanitation's Integrated Water Quality Management Strategy framework.
2. The Rhodes University has given ethical clearance to this research project and I have seen/ may request to see the clearance certificate.
3. By participating in this research project I will be contributing towards enhancing the role of CBWQM projects in ensuring integrated water quality management in South Africa. This will strengthen CBWQM projects, and also benefit society and ecological systems that are impacted by water pollution.
4. I have completed the options for participation in the project [SEE OPTIONS BELOW]
5. My participation is entirely voluntary and should I at any stage wish to withdraw from participating further, I may do so without any negative consequences.
6. I will not be compensated for participating in the research, but costs for participating in the national workshops will be covered (travel and accommodation costs) and any costs associated with attending an interview.
7. There may be risks associated with my participation in the project. I am aware that:

a. the following risks are associated with my participation:

1. the project may raise difficulties for the organization by showing that other organisations are not fulfilling their mandates for water quality management

b. the following steps have been taken to prevent the risks:

1. the project team will not use personal identities or organizational identities in the project reporting unless this is checked and confirmed with me
2. the project team will mediate any arising conflict with organisations who are not fulfilling their mandates for water quality management should such conflict arise in the research process

c. there is a small (10%) chance of the risk materializing.

8. The research team intends publishing the research results in the form of a research report for the Water Research Commission. The research may then also be published in an academic paper form, and as a set of guidelines for CBWQM organisations to strengthen scaling and resourcing approaches for CBWQM in South Africa. However, confidentiality and anonymity of records will be maintained and my name and identity will not be revealed to anyone who has not been involved in the conduct of the research. I will be given full sight of the final research reports before these are published more widely.
9. I will receive feedback in the form of workshop reports after the two workshops, and a draft final project report regarding the results obtained during the study.
10. Any further questions that I might have concerning the research or my participation will be answered by Professor Heila Lotz-Sisitka at h.lotz-sisitka@ru.ac.za or by Dr Jim Taylor at jimtaylor835@gmail.com
11. By completing this survey I am agreeing to give consent to participate in the research, and by completing the informed consent declaration I am not waiving any legal claims, rights or remedies.
12. A hard copy of this informed consent declaration will be given to me at the workshop, and the original will be kept on record, otherwise, it is available on this platform.
13. The team may request to take pictures, video and voice recording for this study but these will only be used with my permission in the reports.

I have read the above information / confirm that the above information has been explained to me in a language that I understand and I am aware of this document's contents. I have asked all questions that I wished to ask and these have been answered to my satisfaction. I fully understand what is expected of me during the research.

By continuing to complete this questionnaire, I acknowledge that I have not been pressurised in any way and I voluntarily agree to participate in the above-mentioned project.

Rhodes University, Research Office, Ethics
Ethics Coordinator: ethics-commitee@ru.ac.za
t: +27 (0) 46 603 7727 f: +27 (0) 86 616 7707
Room 220, Main Admin Building, Drostdy Road, Grahamstown, 6139

Agreement to participate in the CBWQM project

By filling in this section, you are agreeing to participate in the project as per the ethics informed consent request above

Agreement to participate in the CBWQM project (tick those that you agree to be part of)

I agree to complete this questionnaire which provides insights into the enabling and constraining factors influencing CBWQM projects

I agree to be part of a national project workshop where I may be asked to present our CBWQM project.

If possible, contribute to a second national workshop where I will share approaches to scaling CBWQM projects

If requested, participate in an interview to provide more information on our CBWQM project

Give feedback on the written reports from them workshops that I participate in, and the final project report

GENERAL PROJECT INFORMATION

Please give a short description of your CBWQM project

Name of Project*

Your answer

Contact person (Director of the organisation) and contact details (if not yourself)*

Your answer

Relevant contact details for the project (e mail, website etc. other than your contact details above)*

Your answer

Contact Number

Your answer

Project Location & Scope of Activity

Please include a description of where the project takes place, and whether it is local, provincial, national or international in scope.

Your answer

Project participants*

Please include description of range of participants and partners contributing to project. Please include networks, stakeholders and other links.

Your answer

Project lifespan*

Currently Active

Project has ended

PROJECT REVIEW QUESTIONS

We would appreciate any details you are able to share.

1. How does the project engage with policy at international, national and/or provincial and local levels?

Your answer

2. How is the project working on the ground? Share examples of tools being used where relevant.

Your answer

3. Who is actively involved in the project, and how are they being supported to participate?

Your answer

4. What would you describe as the innovative aspects of this project?

Your answer

5. Have you noticed any factors that are constraining or limiting the project?

Your answer

6. What are the learning features of the project?

Please include activities, training and models of learning, significant learning interactions, etc. if possible?

Your answer

7. What are the most important aspects necessary for expanding or extending the project?

We would appreciate your insights around scaling such projects.

Your answer

Any other project information you would like to share?

Your answer

Get link