ANALYSING EQUITY AND ETHICAL DIMENSIONS OF WATER GOVERNANCE CHALLENGES IN THE LOWER SECTION OF THE UPPER VAAL RIVER CATCHMENT, GAUTENG, SOUTH AFRICA

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DEDICATION

I dedicate this thesis to my loving husband Nikita Tavengwa for his support, patience and understanding from the start till to the end; and my three lovely daughters Tanatswa, Tadiwanashe and Tariro for all the time and milestones I missed during my academic journey.

ABSTRACT

Poor water governance practices have been identified as one of the root causes of water problems confronting the South African water sector. This is evident in the lower section of the Upper Vaal River Catchment, where ineffective implementation of the regulatory measures has resulted in multiple incidents of illegal discharge of effluent from municipal wastewater treatment works, industrial and mining activities. Pollution and deterioration of water quality is a major challenge in the catchment; the Vaal River is severely polluted beyond acceptable standards and impacts negatively on other water users who have legitimate rights to the water resources. Pollution not only affects human activities and use, but also has negative impacts on ecological health and functionality. Poor water governance practices raise ethical implications for the rights to water for both social and ecological components. Although many water governance challenges in South Africa have implications that border on values and ethics, the relationship between these concepts has hardly been explored.

In order to contribute towards filling this gap, this study explores water governance challenges and their ethical implications, and then analyse the equity dimensions of key water challenges among institutional actors in the lower section of the Upper Vaal WMA, Gauteng. The study uses a qualitative research approach which involves several methods of data collection: document analysis, workshops, focus group discussions, key informant interviews and participant observation. The data collected were analysed using thematic analysis, and then applied an ethical framework to distil ethical implications of the identified water governance challenges. There are five water governance challenges that were identified, which are i) failure in the implementation of water legislation and regulations, ii) ineffective leadership and management, iii) cooperative governance and poor accountability, iv) decentralisation and ineffective participation, and v) finance, infrastructure, and technical capacity. The deterioration of water quality and pollution due to ineffective implementation of the regulatory system has ethical implications towards protection of the ecological system and sustainable management of the water resources for the present and future generation. Ineffective implementation of the regulatory measure also raises the issue of distributive equity between different water users and between current and future users. These implications are critical particularly when viewed from the perspective of systemic-relational ethical approach which posit that in social-ecological systems, all components ought to be treated with equal regards, and their inherent worth respected in order to maintain the unity of the SES. The idea of equal

regards to the inherent worth of the component implies due respect, in ways that do not undermine the integrity of the entire system. The challenges identified in the system suggest that i) the right of the ecological system to water is undermined due to anthropogenic activities, which may in the long term undermine the functionality of the entire SES; ii) the right of the margined to access to water of the right quality is also undermined, and pollution costs is externalised. These are matters of ethics that thus deserved attention in policy and management considerations.

The study analysed equity dimensions (distributive and procedural), targeting the key institutional water users (i.e., mines, industries, agriculture, municipalities, and the wastewater treatment works) in the lower section of the Upper Vaal River Catchment as equity candidates due to their activities that significantly impact the environment and the water resources. The cost of pollution caused by mining activities, industrial activities and the wastewater treatment works is externalised to other users who are not responsible for the pollution. In this regard study identified key drivers that raise concerns linked to distributive equity, which are) pollution and water quality deterioration, ii) the legacies of mining activities, and iii) poor infrastructure maintenance, vandalism, and theft. Identifying these key drivers of distributive equity concerns is critical in ensuring that the water governance processes are designed in a way that stakeholders and actors reliant on water resources within the catchment have equitable and fair access without the effects of externalised costs from other actors.

The identified water governance challenges in the catchment all borders on ethics, thus an ethical framework is crucial in tackling water related problems. The principles of ethics can be used as guidelines to decision-making process for the management and governance of water resources in South Africa. Therefore, implementing and incorporating principles of the systemic-relational ethics into policy making and water resources management will yield sustainable, efficient, and equitable use and management of water resources.

DECLARATION

The work that is presented in this thesis is the original work of the author and has not been submitted to any institution or university other than Rhodes University, Grahamstown, South Africa. The work of other authors reviewed in this research is accurately cited in the thesis.

Signed: Date:

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LIST OF ABBREVIATIONS

AMD	Acid Mine Drainage
BHNR	Basic Human Need Reserve
CMA	Catchment Management Area
CMF	Catchment Management Forum
DMR	Department of Mineral Resources
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
GDP	Gross Domestic Product
IDP	Integrated Development Plan
MIG	Municipal Infrastructure Grant
NGO	Non-Governmental Organisation
NPO	Non-Profit Organisation
NWA	National Water Act
RQOs	Resource Quality Objectives
RSA	Republic of South Africa
SAHRC	South African Human Rights Commission
SDC	Source Direct Control
SES	Social-ecological System
SR	Systemic Relational
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
WMA	Water Management Area
WQL	Water Quality Licence
WRC	Water Research Commission
WSA	Water Services Act

WSA	Water Services Authorities
WSP	Water Services Provider
WUA	Water User Association
WUL	Water User Licence
WWTP	Wastewater Treatment Plant
WWTWs	Wastewater Treatment Works

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Chapter 1: General Introduction

1.1 Introduction and study rationale

South Africa is a water-scarce country due to its semi-arid climatic conditions (Herrfahrdt-Pähle, 2010; Mukheibir & Sparks, 2003). The country receives an average annual rainfall of 465 mm which is significantly below the world's average annual rainfall of 860 mm (DWS, 2019). Predicted changes in temperature and precipitation from global climate change are likely to increase the current pressure on South Africa's water resources (Mukheibir & Sparks, 2003). Rapid population growth has impacted the task of balancing water demand with the available water resources. Continuous pollution and contamination of water resources from social and economic activities has reduced the availability of freshwater in the country. In short, poor water governance has exacerbated South Africa's water crisis (Weston & Goga, 2016) and has been recognised as the root cause of several problems confronting the South African water sector. For example, the collapse of wastewater infrastructure due to lack of maintenance has greatly contributed to the deterioration of water quality through raw sewage contamination of freshwater systems (DWS, 2013; DWS, 2022; SAHRC, 2021).

Efficient management of water resources is a challenge in the country due to ineffective implementation of the regulatory measures and the collapse of water infrastructure. In the Vaal system, for example, water resources are overexploited owing to illegal abstraction of water for irrigation purposes, amongst others (Ginster *et al*., 2010). Substantial amounts of water, estimated at over 1.5 billion m^3 per year is lost through the collapse of water infrastructure (Venktess 2018) Several farmers abstract water for irrigation without water user licences (WUL), which contributes to overexploitation of water resources in South Africa (Ginster *et al*., 2010). Systemic water governance failure is the primary source of the challenges confronting the water sector in South Africa (Odume *et al*., 2022; Weston & Goga, 2016), therefore improving water governance is critical in addressing water problems. Water governance challenges have manifested in the lower section of the Upper Vaal River Catchment which is located in the Gauteng Province. This has resulted in severe pollution and water quality deterioration of the river systems.

Failure to implement good water governance practice has contributed greatly to the status of water problems in the lower section of the Upper Vaal River Catchment. Improving water

governance practice could eradicate some of the water problems and would ensure water security in the catchment and, more broadly, in South Africa. Water governance has been recognised as a multi-sectoral and dynamic process that involves multiple actors in addressing current water problems (Pahl-Wostl *et al*., 2020). The concept of water governance is complex: there is no agreed definition or universal procedure to follow when practising good water governance although there are normative characteristics of good water governance, such as efficiency, effectiveness, equity, accountability, transparency and inclusiveness (Jiménez *et al*., 2020). Different scholars have adopted and interpreted water governance from different interests, sometimes with conflicting objectives (Araral & Wang, 2013; Erdiaw-kwasie *et al*., 2020; Ross, 2017), resulting in different understandings and usage of the term 'water governance'.

The current study adopts the definition of water governance as a *'social function that helps regulate development and management of water resources and services along with providing guidance towards a desirable state away from an undesirable state'* (Pahl-Wostl, 2019, p. 6). The notion of social function expands the inclusiveness and stakeholders' participation in decision-making on water resources management. Inclusiveness and participation have been recognised as inevitable in implementing effective water governance practice, and they are categorized as attributes of good water governance (Berg, 2016; Jiménez *et al*., 2020; Shunglu *et al*., 2022). Therefore, water governance approaches that promote participation and stakeholder engagement are receiving more attention in the water sector, for example, network and participatory governance.

Implementing good water governance practices is critical in addressing several human-induced water-related problems. The fundamentals of good water governance in South Africa include equity, sustainability, and efficiency. These three values are enshrined in the National Water Act (NWA) of 1998 and they drive how water resources are governed, used, and protected. Other common attributes that are associated with good water governance that have been identified include accountability, inclusiveness, participation, and transparency (Berg, 2016; Jiménez *et al*., 2020; Shunglu *et al*., 2022). Situations where these attributes are absent, are recognised as situations of 'poor water governance'. A lack of accountability on the part of various government departments (national, regional and local) has been identified as one of the top water governance challenges in South Africa (Weston & Goga, 2016). Given that water

holds multiple values and different societal groups hold different values, failure in the water governance system/s raises ethical implications.

There are several water problems confronting the South African water sector that border on ethics and values, yet there is no parallel research or policy inspired by ethics of water governance. Ethics has been recognised as a contributing factor in addressing current water problems because it brings to light and clarifies the diversity of identities, values, and the associated right/s attached to water across temporal and spatial scales (Amir *et al*., 2021; Stefanovic & Adeel, 2021). Values have been recognised as influencing how water resources are used, managed and protected (Groenfeldt & Schmidt, 2013; Schulz *et al*., 2017). In this study, by 'values' is meant *'what specific societal groups or constituencies express at a generalized level to be good or bad*', whereas 'ethics' is a '*systematic concern with the principles by which conduct, morals and values are clarified and justified, as we seek to distinguish between right and wrong in our behaviour towards other people and towards nature'* (Odume *et al*., 2022, p 4). Water conflicts are normally associated with values, given that values are multidisciplinary in nature, and the values that a societal group or institution upholds are not always compatible with each other (Grunwald, 2016). Ranking and prioritising values, then, will require ethical guidance in the process of decision-making, and constructive balancing and trading-off of values (Groenfeldt & Schmidt, 2013).

The study of values and ethics is critical in the management of water resources because it allows one to understand ways in which different societal groups lay claim to water. The interaction of values requires ethical guidance, and the effects of value interaction on the water governance processes, decisions and institutional arrangement. An ethical intervention is critical in water governance and decision-making processes as it helps mediate conflicting values by creating a space for dialogue (Groenfeldt, 2020). In the broader project from which this study emanated, an ethical framework was developed that helps to clarify and shed light on value claims and claimants. The ethical framework draws on consequentialism, deontology, virtue, systemic-relational ethics, and on African ethics, that is, *ubuntu* moral theory (Odume *et al*., 2022). These ethical thoughts bring to light morally acceptable actions from different perspectives. For instance, utilitarianism (consequentialism), which focuses on efficient use of water resources, is popular in the water sector (Bartels, 2016; Ewing & Demir, 2021; Prieto, 2021; Saletti *et al*., 2021). Despite all the importance and advantages that the study of values and ethics brings in solving water problems, these approaches are not explicitly articulated in the water resource governance systems in South Africa (de Wet & Odume, 2019).

The value of equity is becoming increasingly important in tackling the water governance challenges that are exacerbated by the effects of climate change, industrialisation and urbanisation (Özerol *et al*., 2018). In a highly industrialised and urbanised area like the lower section of the Upper Vaal River Catchment, equity is critical in addressing the problem of pollution which is caused primarily by the main industrial players within the catchment, yet the cost of pollution is externalised to other water users within and beyond the catchment. Equity is critical because it pays attention to issues of justice and fairness with regard to access to the benefit of water resources, and to the decision-making process that determines access and institutional arrangement (Grillos et al., 2021; Haie, 2021; Rawlins, 2019). In this regard, paying attention to equity imperatives and dimensions can address unfairness arising from externalization of pollution costs within the catchment.

The current study focuses on two dimensions of equity, namely distributive and procedural equity. Distributive equity advocates for fair distribution of costs and benefits accruing from water resources, whilst procedural equity advocates for stakeholders' involvement and participation in the process of decision, and fairness in representation among affected and interested stakeholders, irrespective of their backgrounds (Grillos *et al*., 2021; Osman & Faust, 2021). Exploring distributive equity is critical to ensure that the water governance processes are designed in a way that promotes equitable and fair use of water resources amongst key institutional water users without externalising pollution costs. Procedural equity is effective in addressing the challenges of stakeholder participation and involvement in the decision-making process. Effective participation and inclusiveness of stakeholders is critical in addressing human-induced water problems, such as pollution, as it yields the culture of accountability and builds a sense of responsible water use. This study focused on the key institutional and bulk water users in addressing the challenge of pollution because it is their operations that have significantly impacted the ecological and ecosystem services derived from the Vaal River system.

As argued earlier in this chapter, values have been recognised as playing a central role in the management and distribution of water resources, and yet there is no concrete discussion about values that underline or should inspire decision-making or policy in the management of water resources. Given that water holds multiple values, and that these values may interact in different ways, an ethical analysis is necessary to clarify the claims that emerge from different value standpoints. The need to clarify the ethical foundations of water management decisions has never been greater. This study adopts an ethical framework developed by Odume *et al*.

(2022) to reflect upon the water governance challenges within the lower section of the Upper Vaal River Catchment, and draws on this framework to distil ethical dimensions of the identified water governance challenges in the catchment. The necessity of an ethical analysis in water governance arises because i) there is an urgent need to clarify values, the way they interact and the way these interactions impact on decision making and the outcomes of such decisions; ii) it brings about clarity on value claims; iii) it mediate constructive dialogue among claimants as well as the normative dimensions of water governance.

1.2 Research aim and objectives

The aim of this study is to analyse equity and the ethical dimensions of water governance challenges in the lower section of the Upper Vaal River Catchment, with particular reference to institutional water users within the catchment.

The aim of the study was achieved through the following objectives:

i. To analyse water governance challenges and their ethical dimensions in the lower section of the Upper Vaal River Catchment.
ii. To analyse equity dimensions among key institutional water users within the lower section of the Upper Vaal River Catchment.

1.3 Methodological overview

The study used a case study approach incorporating the lower section of the Upper Vaal River Catchment. Both primary and secondary data sources were used. Secondary data collection involved analysis of relevant documents: minutes from catchment management forums, government reports, published research papers, and media reports. This analysis was undertaken to gain historical background of the recurring and current water governance challenges. Primary data collection involved a variety of data collection methods, including workshops, focus group discussions, key informant interviews and participant observation.

The purposive sampling method was used to select the participants for the study. Key stakeholders in the catchment who are knowledgeable about the water governance processes and from government departments at national and local level, bulk water users, tourism industries, industries, and non-governmental organisations were selected. A snowballing sampling approach was also used, whereby participants from the interviews referred other knowledgeable stakeholders. The information retrieved was analysed using thematic analysis,

based on the six steps developed by Braun and Clarke (2006), which involved arranging the key findings into themes. To achieve the first objective, an ethical framework was used to distil ethical implications of the identified water governance challenges.

Research ethical clearance and permission to conduct the study were obtained from Rhodes University Human Ethics subcommittee, with ethics approval No. 2019-0687-798. Participation in the study was voluntary and participants were free to withdraw from the study at any time without a penalty. Participants' identities are protected owing to the sensitive issues discussed, and direct quotes from participants, where appropriate, are presented anonymously. Consent for recording interviews and focus group discussions was obtained from the participants orally.

1.4 Study limitations

There are two limitations of the study, mainly in the data collection. Firstly, stakeholders from municipalities and the agricultural sector did not respond or participate in the workshop and key informant interviews. The information gained about agriculture and municipalities was mainly through document analysis and other stakeholders who participated in the study.

A second limitation were the national Covid 19 restrictions that banned face-to-face gatherings and impacted the data collection. A second workshop was cancelled owing to these restrictions, and key informant interviews were changed from face-to-face to online meetings.

1.5 Thesis structure

Chapter 1 provided a general introduction and background to the study, together with the aim and objectives of the study, and the study limitations.

Chapter 2 gives an extensive review of the literature, focusing on the different approaches and the importance of values and ethics in the context of water governance in South Africa.

Chapter 3 explains the research design of the study, elaborating on the methods of data collection, sampling strategies, research participants, and data analysis.

Chapter 4 presents a description of the area of study and elaborates on the biophysical and socio-economic aspects of the study area.

Chapter 5 addresses the first objective of the study, focusing on the exploration of the key water governance challenges in the study area and their ethical implications.

Chapter 6 focuses on the second objective of the study through an analysis of the value of equity and its dimensions, with a key focus on institutional water users within the catchment.

Chapter 7 synthesises the key findings of the study and provides a conclusion and recommendations.

Chapter 2: Literature Review

2.1 Introduction

The current '*world water crisis'* has been linked to mismanagement of water resources and failure in the water governance processes (Akhmouch *et al*., 2018; Nastar, 2014). Water governance has emerged as an important topic across the world (Stefanovic & Adeel, 2021) and has been acknowledged as crucial in achieving sustainable water resources management (Jiménez *et al*., 2020; Özerol *et al*., 2018). It has been argued that the current global water crises, such as water pollution, water quality deterioration, failure of infrastructure are as evidence of systemic governance failure (Dellapenna *et al*., 2013; Leeuwen *et al*., 2015). Improving water governance processes is thus critical to address these challenges (Araral & Wang, 2013; Özerol *et al*., 2018).

Water governance is consequently receiving increased attention in the water sector policy, practices and in research, and has been pursued as a concept necessary for achieving integrated water resource management. However, there are challenges in practising and implementing effective approaches to water governance. The evidence has shown that water governance is a complex concept to deal with, and there is no universal approach to water governance in addressing water problems (Akhmouch *et al*., 2018). Although water governance is widely adopted as a key concept, there is no agreed definition nor a universal way of dealing with the concept. Different schools of thought, organisations and institutions have interpreted the concept from different perspectives and interests. There is a growing body of knowledge that supports the need to transform water governance into a concrete and tangible concept with focus on the complexity and unpredictable outcomes from decision-making and planning (Rodina, 2019).

Water governance models that promote stakeholder participation are receiving more attention in the water sector (Van de Meene *et al*., 2011) and are recognised as being more effective in addressing human-induced water problems like pollution. Decentralisation of power and responsibility to a variety of stakeholders and institutions that are non-governmental have been recognised to be effective in dealing with uncertainties in planning and decision-making regarding water resources (Baldwin *et al*., 2016; Boamah, 2018; Carlisle & Gruby, 2019). Challenges in water governance practice persist in the water sector and the current models and

approaches of water governance do not uncover ways to deal with the complex concept. Introducing the concept of values and ethics in water governance can help to guide the decision-making process and in policies that are more effective in the management, use and protection of water resources (Amir *et al*., 2021; Stefanovic & Adeel, 2021; Wahab, 2021).

Values have been identified as one of the key drivers in the way water resources are used, managed and protected (Heinrichs & Rojas, 2022). Values can be understood as guidelines or abstract goals that people try to adhere to when making decisions (Schulz *et al*., 2017). In relation to natural resources, values can also be understood as an expression of the meaning and importance attributed to them, for example, ecosystem services. In this study, values are taken to mean '*what specific societal groups or constituencies express at a generalised level to be good or bad*' (Odume *et al*., 2022, p 4). In water governance, the water institutions that are involved in decision-making are driven by values; these can be institutional values or assigned values. In some cases, these values may come into conflict, implying a trade-off. The trade-off of values requires ethical consideration as the process of decision-making often requires prioritising and ranking values.

Ethical consideration is crucial in water governance and in dealing with values because it allows one to understand ways in which different societal groups lay claims to water (Arias-Arévalo *et al*., 2017; de Graaf & Paanakker, 2015; Solé & Ariza, 2019). Water-related decisions and planning require ethical guidance. In this study, ethics is taken as a '*systematic concern with the principles by which conduct, morals and values are clarified and justified'* (Odume *et al*., 2022, pg 4). Ethics in the governance of water resources help integrate different and sometimes conflicting values by making them visible and creating an ethical space for dialogue and mediation (**Figure 2.1.**) (Ewing & Demir, 2021; Jonkers, 2019). The way in which different actors or institutions participate in water governance processes is influenced by their values (Schulz *et al*., 2017).

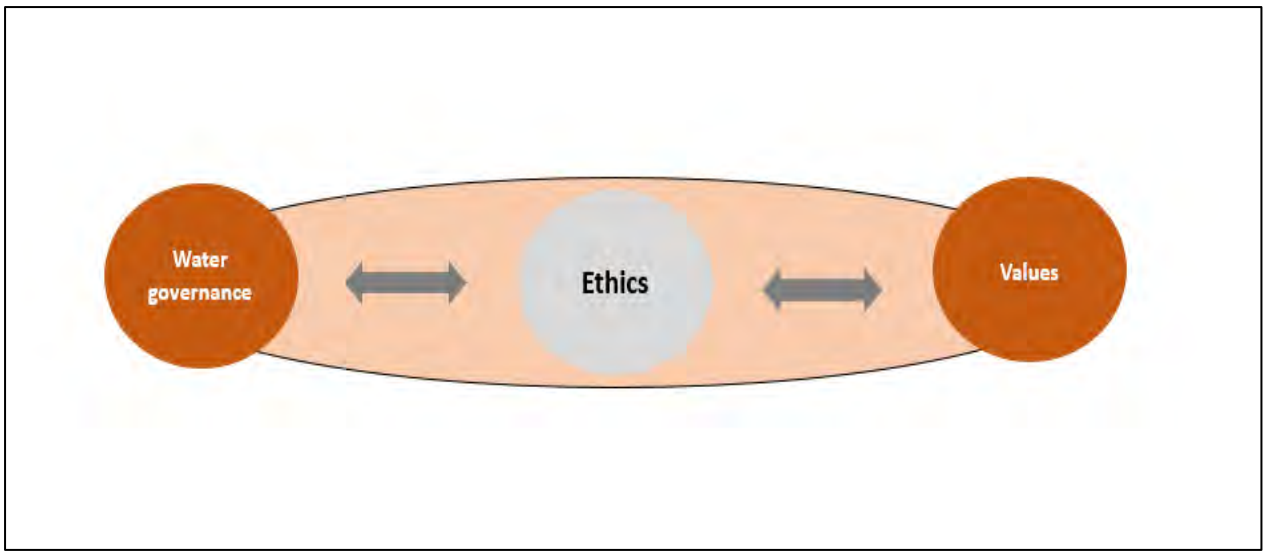

Figure 2.1. Ethics intervention in water governance help to understand and clarify values (Source: Odume *et al*., 2022).

The goal of ethics is to promote practical assistance and conceptualization of various viewpoints while facilitating in maintaining a focus on '*the action, the consequences or motives, which examine the concepts of rights and duties or effects and outcome'* (Liu *et al*., 2011, p. 16). Ethics is perceived as a set of principles that might be used as a guideline for analysing water management options and their consequences both for society and the ecosystem (Grunwald, 2016). The aim of ethics is directed at responding to multiple water governance challenges which have impeded the sustainable management of water resources.

This study explored the ethical dimensions of water governance challenges with reference to the lower section of the Upper Vaal River Catchment. The ethical framework developed by Odume *et al*. (2022) was used to distil the ethical dimension of identified water governance challenges in the catchment. The rest of this chapter begins with a review of value and equity as foundational in South Africa, and then progresses to the review of the relevant ethical considerations in water governance, identifying critical gaps that necessitated the current study.

2.2 Water governance: A complex concept

The differences in the definition of water governance and understanding of the term among scholars and institutions provides impetus for its complexity (Boonzaaier & Brent, 2019; Dai *et al*., 2022; Gupta & Pahl-Wostl, 2013; Moore, 2013; Pahl-Wostl, 2019; Pahl-Wostl *et al*., 2020). The various definitions of water governance indicate that the concept has been consistently viewed as a process involved in decision-making through an institutional

arrangement that engages multiple actors (Akhmouch *et al*., 2018; Berg, 2016; Erdiaw-Kwasie *et al*., 2020). However, the various conceptions of governance has somewhat impacted on the operationalization of the concept within the water sector (Biswas & Tortajada, 2010). Given the problem of pollution in the lower section of the Upper Vaal River Catchment which has resulted in the deterioration of the water quality and ecological health of the river system, this study adopts the definition of water governance by Pahl-Wostl (2019). This scholar defined water governance as a '*social function that helps regulate development and management of water resources and services along with providing guidance towards a desirable state and away from an undesirable state'* (Pahl-Wostl, 2019, p. 6). The perception of water governance as a social function focuses on engagement, inclusion, and stakeholder participation in the decision-making process. This definition enables the participation of non-state actors, but also includes situations where only state actors make actions and decisions, where necessary and appropriate. The South African National Water Act of 1998 advocates for stakeholders' participation and inclusiveness in the decision-making of the management of water resources (RSA, 1998). Decentralisation of water management from national to local institutions through the establishment of Catchment Management Agencies (CMAs), Water User Associations (WUAs) and other local institutions has been key to facilitating stakeholder engagement and participation (Jonker *et al*., 2010).

There is no universal global structure that can be put in place to ensure good water governance (Tortajada, 2010), therefore, water governance must be context sensitive (Erdiaw-Kwasie *et al*., 2020; Yasmin *et al*., 2018). In order to achieve desirable results in water governance, the governance system(s) must be developed to suit local conditions or water problems faced in that area. Good governance should embrace the relationship between governments and societies, including laws, regulations, institutions, and formal and informal interactions which affect the ways in which the governance system functions, stressing the importance of involving more voices, responsibilities, transparency and accountability of formal and informal organisations associated in any process (Tortajada, 2010).

Common attributes of good water governance that have been identified include accountability, transparency, efficiency, participation, deliberation, inclusiveness, evidenced-based decisions, rule of law and adaptiveness; all these are critical to freshwater resources' sustainability (Berg, 2016; Jiménez *et al*., 2020; Shunglu *et al*., 2022). Absence of these attributes is considered as 'poor governance' or 'bad governance' (Weiss, 2000). Understanding the performance of governance arrangements is the first step in improving the management of water resources for

both the short and long term (Akhmouch *et al*., 2018). This is particularly relevant for South Africa, given that many of the water challenges confronting the country have been deemed a result of systemic governance failure.

2.2.1 Water governance in South Africa

The Department of Water and Sanitation (DWS) is the national government authority and the custodian of water resources in South Africa. Water resources and associated services are governed and regulated by two pieces of legislation through different water management institutions. The Water Services Act (WSA), Act 108 of 1997, regulates potable water and related water services which involve the provision of drinking water, sanitation and infrastructure development through the Water Services Authorities (WSA) and Water Services Provider (WSP) (Weston & Goga, 2016). According to the South African constitution, local government (municipalities) are responsible for water and sanitation services, including the potable water supply. The natural or raw water resources (e.g., rivers, dams, and lake) are regulated by the National Water Act (NWA), Act 36 of 1998 (RSA, 1998). This Act involves classifying and determining the requirements of the natural water resources through three water management institutions namely, DWS at the top level of the institutional framework, followed by the catchment management agencies (CMAs) as the second tier, and Water User Associations (WUAs) as the third (Boonzaaier & Brent, 2019).

Water governance in South Africa has been recognised as being in a transitional phase, moving away from bureaucratic governance (top-down) to a more delegated, cooperative (network) and participatory governance (Pahl-Wostl, 2019). The transition is influenced by the implementation of the new National Water Act of 1998 which focuses on decentralisation of water-resource management through the establishment of Catchment Management Agencies (CMAs). The CMAs are to be established through stakeholders and community contributions in decision-making and to participate actively in the respective water institutions established in the proposed CMA's water management area (Meissner, 2016). These water institutions include the catchment management forums (CMFs) and Water User Associations (WUAs). Currently only two of the initially planned nineteen CMAs are established and functional. The proposed CMAs were reduced to nine by the minister of the Department of Water and Sanitation in 2012 due to implementation challenges (Weston & Goga, 2016).

Different modes of water governance were introduced into the South African water sector after the apartheid era. 'Modes of water governance' refers to a certain logic and form through which

governance can be realised (Pahl-Wostl, 2019). In South Africa, the Apartheid Water Legislation established the government as the only actor in decision-making (bureaucratic governance). The power and authority in the decision-making process flowed through a formal hierarchy, from the national government (DWS) to the local governments (top-down approach). A combination of hierarchical, network, and market style as envisaged by the South African water policy requires the role of the government as meta-governor (Weston & Goga, 2016). Market-led governance is based on greater empowerment of stakeholders for water management and ownership of water, whilst network or distributed governance builds on the co-operation of private civil and public actors and a decentralised management approach (Pahl-Wostl, 2019; Romano & Akhmouch, 2019). The establishment of substitutive networks at local scale is partly impeded by the power of the government to make major decisions that influence the local level (Weston & Goga, 2016).

The bottom-up approach is recognised as promoting sustainable management of water resources because it influences active participation of water users by yielding a sense of belonging and accountability (Cosgrove & Loucks, 2015; Erdiaw-kwasie *et al*., 2020; Lee *et al*., 2022). The NWA 1998 promotes the management of water resources at the lowest possible level by involving the public. The CMFs and WUAs are recognised as vehicles for participatory governance by bringing in stakeholders, national and local governments together in the management of water resources. The combination of both top-down and bottom-up approach has been recognised as crucial in resolving water challenges as it ensures cooperation among stakeholders, and it is regarded as practice of good water governance (Lee *et al*., 2022).

The South African water policy aims at balancing the combination of network and hierarchy with some consideration of market-based approaches. However, the government's ability to rule and serve as a meta-governor is limited. This limitation ultimately results in poorer water management in effectiveness, and in conflicts rather than synergies between governance modes. Three top water governance challenges that have been identified in the South African water sector (Weston & Goga, 2016): i) the challenge of ensuring an effective regulatory system, ii) the lack of accountability at a variety of levels, and iii) the failure to engage the private sector and civil society actors to strengthen the management of water resources (cooperative governance).

The challenge of ineffective implementation of the regulatory system has caused multiple instances of pollution in the lower section of the Upper Vaal River Catchment, resulting in the

deterioration of water quality of the Vaal River. Although values have been recognised as key drivers of how water resources are governed, used, protected and managed (Schulz *et al*., 2017), the study of values has not been explicit in the water sector in South Africa until recently (Odume *et al*., 2022). Understanding the concept of value can contribute to improving water governance practice and the management of water resources by paying attention to how values influence decision-making and how different values may interact in various ways.

2.3 The concept of values

Values play a central role in how water resources are used, managed and protected (Groenfeldt & Schmidt, 2013; Schulz *et al*., 2017; Stenmark, 2017), and they have a significant influence on 'human-water relationships', and the extent of the willingness with which people may take responsibility in the management of water resources (Odume & de wet, 2016). People's attitudes and behaviours are influenced by their views about what is right and wrong (Wahab, 2021), and therefore, the study of values is critical in the management of water resources as it brings to light ways in which values influence the use and management of water resources. The study of values is recognised as complex owing to the multidisciplinary nature of the concept. In the study of values, it is important to pay attention to how the values interact and their effects on the water governance processes, decisions and institutional arrangement.

The conceptualisation of values differs, depending on the discipline. For example, assigned values have received more attention in the field of environmental ethics in the form of intrinsic versus instrumental values of water, and how such ascription of values should form the basis of human environment relationships and action (de Wet & Odume, 2019; Grunwald, 2016; Verma, 2019). The dichotomy between intrinsic and instrumental values has led to the introduction of the concept of relational values, which emphasises the relationship between humans and the rest of nature (de Wet & Odume, 2019; Odume & de Wet, 2019). De Wet and Odume (2019) introduced the concept of systemic-relational values such as interconnectedness and interdependency, arguing for three domains of values, which are: the component of a system, relationships between the components and their subcomponents, as well as the system as a whole. In the field of ecological economics, the benefits that people get from nature (natural resources) are valued in monetary and non-monetary terms (Schulz *et al*., 2017). Ecological economics differ from environmental economics, because they involve multiple ways in which the environment is valued, for example, the ecological and economic values of

water, and the environmental economics focuses only on the human well-being, and not on the service or goods being consumed.

Values are used to describe cultural groupings, communities, and individuals, to monitor development through time, and to explain the driving forces behind attitudes and behaviour (Schwartz, 2012). Roobavannan *et al*., (2018, p. 1341) defined values as '*desirable, trans-situational goals, varying in importance, that serve as guiding principles in people's lives'*. The current study defines values as '*what specific societal groups or constituencies express at a generalised level to be good or bad conduct*' (Odume *et al*., 2022, p. 2). The behaviour or action and practices of institutions that are actively involved in the water governance processes are influenced by values that are promoted at the institutional level. Different institutions or societal groups may hold and promote different values (e.g., security, benevolence, achievement) of varying degrees of importance. This means that a particular value may be considered more important by one certain societal group than another.

Water is a natural resource that is deeply rooted in society's cultural and religious values (Grunwald, 2016). In the management of water resources, cultural and social values are seen as major influences on how decisions are made (Cosgrove & Loucks, 2015; Heinrichs & Rojas, 2022). Social values are identified as having an indirect influence on the management of water resources via the social institutions and physical artefacts involved in the decision-making process. Cultural differences significantly influence how water is perceived, managed and valued in various communities (Cosgrove & Loucks, 2015).

Governance-related values are mainly recognised as attributes of good water governance (Jiménez *et al*., 2020; Schulz *et al*., 2017). In Schulz *et al*. (2017), the scholars categorised values into three groups: fundamental values, assigned values, and governance-related values. Fundamental values are those related to abstract trans-situational goals and are more enduring. Assigned values are those that humans ascribe to the rest of nature, such as intrinsic versus instrumental values, for example, economic and aesthetic values. Governance-related values are derived from the normative view of governance and are mostly characterised as the attributes of good governance, and include equity, sustainability, efficiency, accountability and transparency (Schulz *et al*., 2017).

In South Africa, the value of equity, efficiency and sustainability are enshrined in the NWA of 1998 (RSA, 1998) as foundational values guiding the way in which water resources are managed, conserved, developed, and protected. The value of equity is becoming increasingly

popular in the water sector, and research is being carried out to address issues pertaining to justice and fairness in the distribution of water resources amongst competing users, particularly in South Africa (Carolini & Raman, 2020; Haie, 2021; Jeffrey, 2018; Kazemi & Bozorg-haddad, 2020; Osman & Faust, 2021; Rawlins, 2019). This study explores the equity dimensions arising from water governance challenges in the lower section of the Upper Vaal River Catchment.

2.3.1 Equity as a key value for water resource governance in South Africa

In South Africa, equity is at the heart of post-apartheid water reforms in addressing past racial inequalities in the distribution of and access to water resources (Rawlins, 2019). Equity is enshrined in the NWA of 1998 as one of the key principles that informs water governance in South Africa. Equity was described in the Guide to the National Water Act of South Africa as "the fair distribution of costs and benefits of water resources and fairness in the participation of individuals in the decision-making" (RSA, 1998). This conceptualization of equity has been recognised as insufficient in addressing water justice (Suiseeya, 2016), as it focuses on only two dimensions, that is, distributive and procedural equity, and ignores two other dimensions, that is, contextual and recognition equity. Contextual equity and recognition equity are recognised as critical in the South Africa water sector, given the contextual history which hindered many people from acquiring the capabilities to engage meaningfully in decisions of resource allocation and access (Rawlins, 2019).

Distributive equity has been described as the fair allocation of benefits, costs, risks and burden among societal groupings and/or stakeholders (Yalew *et al*., 2021). Given the pollution and deterioration of water quality in the Vaal River, this study explores the challenges and concerns that result in unfair distribution of costs and benefits amongst different water users in the catchment. The target candidates of equity are the key institutional water users in the catchment, identified as industries, mines, bulk water users, municipalities, WWTWs and agriculture. The activities carried out by these key institutional water users in the lower section of the Upper Vaal River Catchment have negatively impacted the water quality and quantity, hence affecting other water users who have legitimate rights to the water resources.

Consequence-based and rule-based theories (**Table 2.1.**) are often applied in the interpretation of distributive equity. Utilitarianism and welfare economics are the dominant worldview in consequence-based theory. Utilitarianism seeks to achieve the greatest good for the greatest

number of people (Akomolafe, 2019; Prieto, 2021), whereas welfare economics is concerned with maximizing individual utilities as a function of aggregate social welfare (Vos & Boelens, 2018). Efficiency in terms of distribution of benefits and costs is important in realising utilities for both welfare economics and utilitarianism.

Table 2.1. Theories of justice applied to distributive equity (Bartels, 2019; Vos & Boelens, 2018).

Theories of distributive justice	**Principle**
Consequence-based:	
Utilitarianism	Greatest good for greatest number of people
Economic welfare	Rewards to those producing highest economic value
Rule-based:	
Egalitarianism	Equal share
Libertarianism	Equal rights
Needs-based	Rewards according to different needs
Merit-based	Rewards according to contribution

The rule-based theories of distributive justice focus on the application of fair rules in sharing and allocating benefits, costs, and risks among people and social groups (Carolini & Raman, 2020). These theories focus on the rules applied leading to outcomes, which include egalitarianism, libertarianism, merit-based and needs-based shares. Libertarianism emphasises the freedom of equal right to opportunities for every member in the society (Bartels, 2016; Vos & Boelens, 2018). Egalitarianism and merit-based are two contrasting theories; in an egalitarian society, costs and benefits are distributed equally among individuals, regardless of their starting point (Reidy, 2020), whilst a merit-based system promotes the proportional allocation of benefits based on the relative contribution of the individual to the productive activity from which the benefits are derived (Noh, 2020). In a needs-based system, it is argued that justice ought to recognise and be sensitive to the different needs of people because of inherent disadvantages imposed upon them by societal structures (Bauer, 2018, 2022). This study draws on the egalitarian theory to analyse equity among key water user institutions within the lower section of the Upper Vaal River Catchment, particularly with regard to water use, access, and the impact of such water-use activities.

The decision-making process affects how costs and benefits are distributed among different societal groups. The way in which people participate in such decisions, including the decision of who participates and how such participation is achieved is the domain of procedural equity. Procedural equity has been defined as fairness in the participation of stakeholders in the process of decision-making (Grillos *et al*., 2021; Osman & Faust, 2021), and it advocates for stakeholders' involvement and participation in the process of decision-making, and fairness in representation among the stakeholders of different levels and backgrounds (Grillos *et al*., 2021). Procedural equity pays attention to issues of power dynamics, access to information, powerful knowledge, and factors that may impact on or result in unequal participation, for example, the redress of historic inequalities of the apartheid regime in South Africa. Procedural equity addresses issues like inclusivity, participation, and representation, which are recognised as crucial in the sustainable management of water resources. The challenge is how to make public, private, and societal actors more active and directly involved in solving problems and in influencing decision-making processes. In South Africa, the catchment management forums (CMFs) are recognised as platforms for stakeholder engagement, but their effectiveness in influencing decision-making in the water sector is vague.

Recognitional equity stresses the relevance of respect and due regard for people's identity, culture, and values which influence people's conception of and relationship with water (Gurney *et al*., 2021). Recognitional equity sheds light on vices such as discrimination, oppression, and domination based on one's identity (e.g., race, ethnicity, sex, nationality, religion), values and culture as injustices and unfair practices (Bartels, 2016). The literature reports that impoverished communities and people of colour are disproportionately exposed to pollution (Banzhaf *et al*., 2019; Osman & Faust, 2021; Rawlins, 2019) and, therefore, recognitional equity is important in addressing the disproportionate distribution of costs and benefits in the water sector, and commonly the need-based theory is applied in this situation.

Contextual factors (political, policy, and governance arrangement) influence how people participate and have influence in decision-making, and how the costs and benefits of water resources are distributed (Grillos *et al*., 2021). Water legislation is considered as the most effective way of formalising procedural and distributive equity arrangement (Jeffrey, 2018). In South Africa, the NWA 1998 guides how water resources are managed and distributed in the country and differs from the old NWA of 1956 which gave right of ownership and access to water resources to landowners, benefiting white farmers at the expense of the impoverished

societies. Even though the NWA of 1998 advocates for equitable distribution of costs and benefits and fair participation of individuals in the decision-making process, irrespective of their background, the challenge remains in implementation and practice.

Equity may operate at different social scales, for example, individual, community, sub-national, and global (Xu *et al*., 2019), and can be applied in two ways, either vertically or horizontally. Vertical equity takes into account the various needs and capacities of individuals and communities when distributing goods and services, whilst horizontal equity is the equitable distribution of products and services among all groups (Osman & Faust, 2021). Evidence has shown that equity is broad, and it has been argued that unless the goal of equity is defined, it may become impossible to measure, monitor and track equity-related improvement or otherwise (McDermott et al., 2012). A focus on the scale and goals of equity may thus help to identify and define the necessary parameters of equity. In the current study, the scale of the equity analysis is the lower section of the Upper Vaal River Catchment, and the target or candidates of equity are the key institutional water users, or bulk water users within the catchment, and the goal of distribution is egalitarian. Inequalities, either in the form of distributive or procedural inequity, have ethical dimensions to the extent that rights may be impacted. In this regard, ethical considerations in the context of water governance are of fundamental importance. In this study, I draw on the realm of ethical thinking to explore the implications of water governance challenges in the catchment.

2.4 The relevance of ethical considerations in water governance

Ethics is a branch of philosophy that deals with human behaviour which could be right or wrong (Wahab, 2021). Problems confronting the water sector are mainly human-induced problems because human behaviour influences how people interact with the environment (water resources) (Amir *et al*., 2021); the multiple ways of human interaction can have positive or negative impacts on the environment. In the management of natural resources (water), ethics brings to light what is right and wrong in interactions with the environment; people need to be able to distinguish between what is right and wrong for the environment and advocate for the right action. Adopting the ethical approach and considerations in water use and management have been identified as achieving long-term sustainable water resources (Amir *et al*., 2021; Shanono, 2021; Stefanovic & Adeel, 2021).

In water governance, an ethical framework can be used to guide the judgements about values towards the use and management of water resources and can be used as principles to guide decision-making process (Jennings & Gwiazdon, 2021). Ethics helps in clarifying the values and claims, and the implications of such claims about water access, rights, use, protection and development. The field of ethics addresses the why- and how-related questions, for example understanding why the value of equity can come into conflict with the value of efficiency or sustainability, and how the pursuit of equity impacts on the realisation of efficiency or sustainability (Odume *et al*., 2022). Ethics is essential in water governance because it provides different strategies for each situation, as water governance challenges are diversified and require a different solution to each problem. Odume *et al*. (2022) developed an ethical framework for analysing water value claims which draws on the dominant theories of ethics: consequentialism, deontological ethics, virtue ethics, ubuntu moral theory, and systemic-relational theory (Becker & Hamblin, 2021; Ewing & Demir, 2021; Michael George, 2021; Saletti *et al*., 2021).

Humans have become a principal driver of environmental change, climate change, landscape change, so altering the quality and quantity of freshwater resources (Cosgrove & Loucks, 2015). Given the multi-disciplinary nature of values in water resources and the potential for different interactions, in most cases the interaction results in conflict. Conflictual interaction of values requires ethical guidance to strike a constructive balance and mediate between conflicting values (Johns, 2021). There is a growing interest in developing a practical field of water ethics as was adopted from the field of environmental ethics and began with a UNESCO initiative (1998–2004) which analysed the best ethical practice in various water sectors, including domestic water use, irrigation, and ecological health. The process of helping to bring to light convoluted patterns of reasoning, as well as identifying and evaluating core versus negotiable values in a process of moral values mapping, can find useful allies in the philosophical profession (Jennings & Gwiazdon, 2021).

An ethical approach to water governance does not essentially seek for a single solution to water problems, but advocates for different choices which are made after ethical reflection (Moorthy & Jeyabalan, 2012). Ethics focuses on the decisions or choices essentially made from a human perspective (COMEST 1999–2002), and reflection on the ethical dimension of water is critical in the management of water resources. Doorn (2013) elaborated five social dimensions of water that raise ethical implications and which need to be considered in the field of water governance

and ethics. These social dimensions of water are: i) water as a risk, a scarce resource and a service, ii) water in terms of goods and property rights, iii) water as a human right, iv) the transboundary and global dimension, and v) the value pluralism of water (Doorn, 2013).

The ethical dimension which views water as a risk to society can be through natural- or human-induced flooding or waterborne diseases. Waterborne diseases caused by sewage contamination may have serious ethical implications and raise the issue of distributive justice (utilitarianism) amongst different water users (those who use raw water are especially severely affected). Water as a scarce resource has effects on the availability of water in terms of appropriate quality and quantity, as well as the reliable supply of water owing to the uneven distribution of water across the communities. Viewing water as a service focuses attention on the maintenance of water infrastructure to achieve efficiency and reliability of the water supply. Water outages have increased due poor maintenance of water infrastructure, with the impoverished communities in South Africa most widely affected. All these situations raise ethical issues which, in turn, raise the issue of distributive justice and the impact on the concept of water as a human right.

The notion of a human right to water raises ethical implications in the failure of delivering water services to people, as in the case of the failure of municipal infrastructure and thus the failure to distribute water services in the community. This issue raises serious ethical implications of social justice. The human right to water and sanitation was declared by the UN in 2010 (Grunwald, 2016; Jonkers, 2019), meaning that access to water and sanitation are necessary preconditions of human life (Ünver, 2008). Human right to water is linked with human dignity: 'There is no life without water, and those denied it are denied life' (Rahaman & Varis, 2005). Ethically, a clear imperative follows to ensure the fulfilment of this right for today and in the future. In South Africa, the notion of a human right to water is captured in the concept of Basic Human Need Reserve (BHNR), and entails the quantity, quality, and reliability of a water supply for domestic purposes. This ethical dimension of the human right to water also raises the issue of public-good and common pool resource.

'Water for all' is a common quote in South Africa water resource management and indicates that water belongs to everyone (which raises ethical dimension of water as a public-good and a common pool), with the national government (DWS) as the custodian. It is therefore the duty of the national government to ensure equal access to water and sanitation for everyone. This duty raises ethical issues of social justice; the decisions made in water resource management

and distribution should treat all people equally, or treat them proportionately (Bandyopadhyay *et al*., 2019). However, challenges emerge due to the scarcity of water in terms of quantity, quality, and service delivery. Some exclusion mechanisms have arisen through the value of efficiency, in terms of which, the economic value of water is manifested in the form of cost recovery for service delivery (Wellington, 2021). The economic value of water through water pricing has serious ethical implications in South Africa because of the injustices and inequalities that were embedded in the past apartheid regime.

Water continually confronts humans with their upstream and downstream interdependency (Jennings & Gwiazdon, 2021), and the solidarity ethical principle emerges owing to the transboundary nature of water. Transboundary river systems are primarily governed and managed through international agreements aligned with the provisions of the United Nations Convention on the laws of the non-navigational uses of international watercourses (Futehally, 2021). Provision is of primary importance in this context because it deals with equitable and reasonable utilisation of international water resources. The upstream states mainly emphasise the equitable utilisation for developing water resources through the principle of sovereignty, whilst the downstream states emphasise reasonable utilisation and avoiding harm to other water resource users for arguing for retention of historic rights. A good example is the Nile River system, between the downstream (Egypt) and upstream (Ethiopia). The ethical principles of solidarity between upstream and downstream states, and that of subsidiarity are critical in resolving disputes in the transboundary governance of water resources. Further, at national level, rivers flow through multiple catchments, and different upstream water users can negatively impact the users downstream. For example, pollution from upstream constrains the legitimate right to water as a basic human right for downstream water users. The ethical principle of solidarity and subsidiarity is implemented for dispute resolution in processes of water governance.

The ecological dimension of water raises ethical implications whereby natural resources have to be protected and sustainably managed. The South African water legislation recognises the value of the ecological system through the ‘ecological reserve’, exists to protect and sustain health water ecosystems. Balancing social and ecological needs is always a challenge in managing water resources which are overexploited to meet human needs at the expense of the ecological system. Environment ethics resonates with the sense of living relationally in the world (Kavalski, 2020), and relational ethics reflect acknowledgement of and responsible adaptation to the turbulent reality of social-ecological systems (SES) interactions. Broadly

speaking, relational values are those values linking people and ecosystems via tangible and intangible relationships to nature, as well as the principle of virtues and notion of a good life that may accompany these (Klain *et al*., 2017). The systemic-relational approach adopts the relational value as a new domain of value articulation distinct from the dichotomy of intrinsic and instrumental value that has dominated environmental ethics for decades (de Wet & Odume, 2019; Himes & Muraca, 2018).

Despite the importance of ethical approaches in solving water-related problems, an ethical approach has not been promoted for use in water-resource management processes, water governance or policy-making decisions. The current study adopts an ethical framework recently developed by Odume *et al*. (2022) which draws from environmental ethics (Odume & de Wet, 2019), water justice (Doorn, 2013), and water ethics (Brown & Schmidt, 2010). The ethical framework was used in this study to distil the identified water governance challenges in the catchment.

2.5 Conclusion

Water governance has been recognised as a critical concept in achieving sustainable management of water resources around the world. Challenges in implementing effective water governance practice have pervaded the water sector and have impeded sustainable management of water resources. Values influence the institutional arrangement and order the way water resources are governed. Further, values and ethics pervade all aspects of water management, including water use allocation, social ordering, pollution control and the notion of healthy ecosystems (Brown & Schmidt, 2010). Ethical consideration is critical in water-resource management and governance as it brings an understanding of the implications of each decision and diverse options for different scenarios. The value of equity is becoming increasingly popular in the water sector in addressing several human-induced water problems, such as pollution, water allocation, and infrastructure development. The current study explores the ethical and equity dimensions in addressing water governance challenges, with reference to the case study of the lower section of the Upper Vaal River Catchment.

Chapter 3: Materials and Methods

3.1 Introduction

This study draws on qualitative data from both secondary and primary sources. Various qualitative techniques of data collection were used to gain insights into the water governance challenges in the study area. This involved analysing documents (e.g., minutes from CMFs, published research papers, government reports, media reports) and primary sources such as workshops, focus group discussions, key informant interviews, and participant observation (primary data collection). A qualitative research approach was critical for this study to gain an in-depth understanding of the water governance challenges and concerns of distributive and procedural equity within the catchment from key stakeholders' experiences and knowledge.

3.2 Methodological framework

To analyse the ethical dimensions of the identified water governance challenges, the framework developed by Odume et al. (2022) was used (Figure 5.1). The framework draws insights from water justice literature (Doorn, 2013); water ethics (Brown & Schmidt, 2010); and environmental ethics (Odume & de Wet, 2019). The framework views water from multiple perspectives, such as social, ecological, and cultural as well as holistic, social-ecological dimensions. Values in the management and governance of water are multi-disciplinary in nature (Schulz et al., 2017) and involve both social and ecological dimensions. Therefore, managing water resources in the context of social-ecological systems (SES) as well as paying attention to the interaction of the components is critical. Figure 5.1 summarises the aspects that guided this study in distilling ethical implications of the identified water governance challenges.

Figure 3.1. Ethical framework for distilling ethical implications of the identified water governance challenges (Odume *et al*., 2022).

In the social dimension, the framework draws mainly on the work of Doorn (2013) on the social characteristics of water that have ethical implications. Here, water is seen both as a risk, a scarce resource, and a service. This holds distributive equity implications in terms of how the services and risks flowing from water governance are distributed among interested and affected stakeholders. The primary ethical concern here is whether these services and risks are distributed in ways that are just, fair, and equitable. The distribution focuses not only on the costs and benefits, but also extends to fairness in participation in the decision-making process of water management. Participation or stakeholder engagement is identified as an inevitable denominator in the sustainable management and governance of water resources.

The framework elaborates on the responsible use of water, and here the ethical concern is on sustainable use of water resources without compromising future use and the functionality of the ecosystem, and on ensuring fairness and equity between competing uses of water in the catchment. Responsible use of water extends to transboundary aspects as well, ensuring fair, equitable and reasonable use of water resources that will not negatively impact on the downstream water user, in this study, those in the Middle, Lower Vaal WMA and Orange River.

The notion of 'water and sanitation as a human right' raises ethical concerns. Because water has been identified as a human right, those that are denied access to water are denied their right to life. The human right to water as conceptualised in South Africa implies the Basic Human Need Reserve, for example, water for drinking, sanitation, washing clothes, cooking and household hygiene. The ethical concern here is whether people have access to water in all dimensions, such as quantity, quality, reliability of supply, affordability, location and maintenance of water infrastructure, access to information and participation in the water governance process. All these are critical in realising the dimension of a human right.

The ownership of water and the property rights attached to it have significant ethical dimensions. If water is seen as a common-pool resource, or a public good with no form of exclusion, then it is likely that the value of water would not be fully recognised, which may lead to over-exploitation and ultimately the tragedy of the commons. However, attaching economic value to water as a means of exclusion raises significant ethical challenges, particularly that of affordability. Thus, economic value can only be attached to water commensurate to added value by the responsible authority, bearing in mind the imperative for equity in terms of water access.

The mismanagement of water resources not only affects humans (social aspects) but also affects ecological health and functionality. The framework recognises the ecological value, whereby the environment is recognised as valuable not only because of how it benefits humans, but also because, of its essence, it is worth preserving (Amir et al., 2021). The environment holds value that needs to be considered separately in decision-making processes, without focusing on satisfying social or economic needs. The ecology holds the ecosystem function and species to flourish in their natural environment. Therefore, the management and use of water resources must sustain ecosystem function, which means not compromising the components of the ecosystems.

The framework emphasises the consideration of the aspect of cultural values in decision-making, and careful balancing of these values with other values, for example economic value. Trading off the cultural values raises ethical implications as culture holds strong sentiments in the social lives of people, like identity shaping. For example, in some societal groupings, rivers are identified as ritual grounds and sites of worship.

The framework recognises the interconnectedness and interdependence of the social and ecological systems when governing water resources. Here, the emphasis is on the fair, respectful and equitable treatment of the SES components, implying that value, in terms of inherent worth and instrumental values are situated at the system level, components of the system, as well as the relationships (de Wet & Odume, 2019; Odume & de Wet, 2019). The ethical implication of this dimension is that governance decisions are to be made in ways that recognise the claims and inherent worth of the all the SES components and that perpetuate the functionality and sustainability of the entire SES.

3.3 Research design, participants, and sampling

Developing an effective research design for the study was essential as it guided the structuring of data collection methods and analysis (Saunders *et al*., 2009). The study made use of case study research design, using a qualitative research approach which required examining and exploring water governance challenges and analysing equity dimensions in the lower section of the Upper Vaal River Catchment. The qualitative research approach involved understanding and appreciating the context of water governance processes and the emerging challenges, and the complexity of the research (Erdiaw-kwasie *et al*., 2018; Tomaszewski *et al*., 2020). The qualitative approach can be used to provide a comprehensive review of water governance and equity challenges in the catchment in order to distil the ethical implications.

The purposive sampling approach was used to target participants who were knowledgeable and had experience in water and water-related issues in the catchment. The selection of participants required identifying key stakeholders who were actively participating in the water governance processes in the study area and had extensive knowledge and experience about the research topic. Analysing minutes from catchment management forums was helpful in identifying actively participating and more involved stakeholders in the water governance processes of the catchment. A snowballing sampling technique was also used for this study as participants referred to other stakeholders who had experience and knowledge of water governance processes.

The research participants selected to participate in this study were drawn from national government (Department of Water and Sanitation), industries, non-profit organisations, researchers, bulk water users and distributors, wastewater treatment private companies, tourism and mining. A total of twenty participants were involved in the study, of which ten were selected for the key informant interviews and the other ten participated in the workshop.

3.4 Data collection methods

The study used several methods of data collection owing to the complex nature of water resources and issues around water governance. The different techniques used included both secondary and primary data sources (**Figure 3.2**). By using the different methods of data collection, depth and breadth were achieved through triangulation (Jahanzeb *et al*., 2021; Miller & Brewer, 2003; Msengwa *et al*., 2021; Reo , 1998).

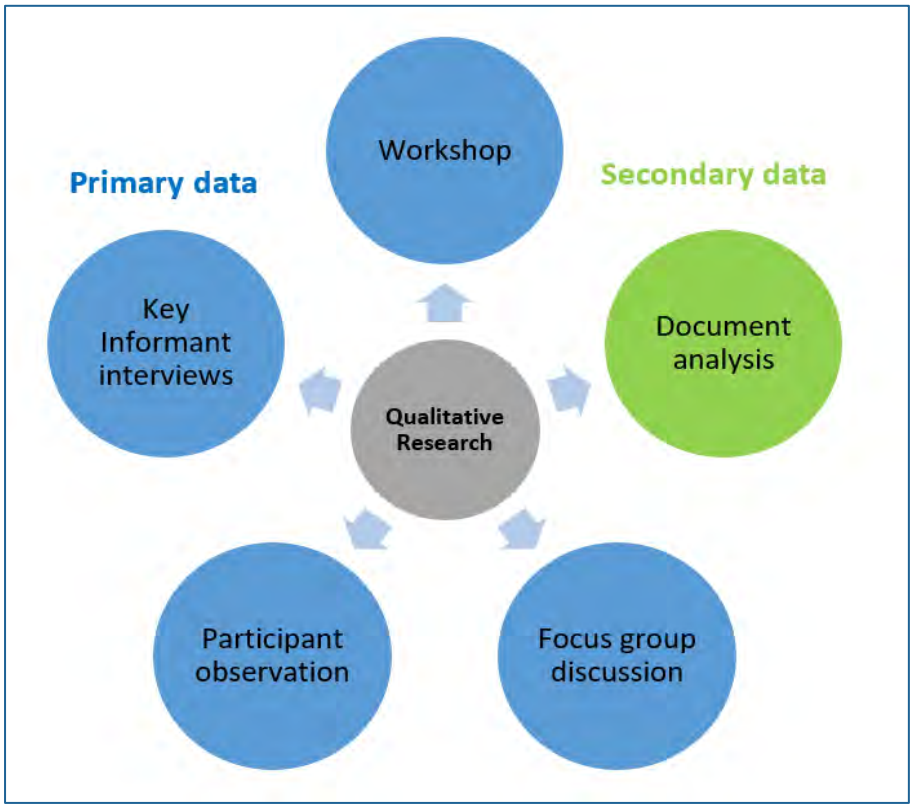

Figure 3.2 Research methods of data collection used for the study.

3.4.1 Secondary data collection

Secondary data are usually those collected by other researchers, or for purposes other than the purpose of the current research (Johnston, 2014; Yayeh, 2021). For this study, data were

generated from document analysis which involved the analysis of minutes from CMFs, published papers, media reports, government reports (see **Appendix 1a-d**). Secondary data collection was used to gain an historical background and a broader view of water governance and equity challenges in the catchment to inform the collection of primary data.

Document analysis

Document analysis is a methodological process for assessing and evaluating documents from both electronic and printed sources (Bowen, 2017). For this current study, document analysis involved examining data from CMF minutes, published research papers, government reports, research theses and media reports (see **Appendix 1a-d**). The data from the documents were analysed and interpreted to extract meaning, understanding, and develop empirical knowledge of the water-related issues in the catchment (Wood & Sebar, 2020). The analytic procedure involved finding relevant information, selecting, evaluating, and synthesising data contained in the documents mentioned above (Bowen, 2017).

The CMF minutes analysed for the current study were retrieved from the website of "The Reservoir" (http://www.reservoir.co.za/) (see **Appendix 1a**), which hosts minutes of meetings from the Vaal Catchment Management Forums. Three CMFs were selected on the Barrage Catchment: the Klip River Forum, the Blesbokspruit Forum and the Leeu-Taaiboschspruit Forum. The Barrage Catchment Management Forums serve as platforms that bring together all affected or interested stakeholders within the catchment. Stakeholders within the Barrage Catchment Forums include water users (i.e., industries, mining companies, and agriculture), government representatives (at all levels), non-governmental organisations (NGOs), consulting companies, community members, academics, and researchers.

The stakeholders meet quarterly with updates on issues that affect water quality and quantity in the catchments, for example, spillage incidents and challenges that have occurred which impact on meeting the resource quality objectives (RQOs) of rivers within the catchment. The forum minutes that were analysed covered a period of 19 years, from 2002 to 2021. These minutes were retrieved and analysed, searching for main themes as well as patterns of recurrence of dominant themes. Themes were then plotted on a frequency distribution graph to show patterns of i) dominant themes, ii) frequency of occurrence of dominant themes, as well as iii) themes that had occurred previously, but no longer emerged, suggesting they had been addressed. The other documents that were analysed include government reports (see **Appendix 1b**), published research articles (see **Appendix 1c**), and media reports (see **Appendix 1d**).

3.4.2 Primary data collection

Primary data collection methods were structured in a way to gain more understanding of the issues reflected from the document analysis (chiefly, the analysis of forum minutes), and meeting the set objectives of the study. The primary data collection methods used for the study involved a workshop, focus group discussions, key informant interviews and participant observation.

Workshop

The workshop's focus was to engage with the research participants on the ethics, values, and water governance challenges in the lower section of the Upper Vaal River Catchment. A workshop is a setting where a group of individuals engage in learning, knowledge acquisition, innovative or creative problem-solving in response to a domain-specific issue (Ahmed & Asraf, 2018). For the purpose of data collection, it was critical that the design of the workshop was focused on ways that allowed the elicitation of responses aimed at addressing the research aim and objectives. The workshop was designed in a way that addressed power imbalances among the stakeholders, making the discussions non-judgemental and encouraging the research participants to engage and interact in open-minded discussion.

An email invitation to the workshop was sent a month before to stakeholders from the Vaal Catchment who were selected using a purposive sampling approach as described earlier in **Section 3.4**, targeting stakeholders within the catchment who were knowledgeable about water governance issues and actively participated in water resource management processes. The invitation email was sent to the selected stakeholders, together with an attachment that comprehensively described the nature and scope of the workshop (see **Appendix 2a**). A reminder email was sent a week later and follow-up calls were made to encourage stakeholders to participate.

The workshop was held at Sarabi Country Lodge in Kempton Park, Johannesburg on 21 August 2019, and was titled: *Workshop on the ethics and water governance in the Lower section of the Upper Vaa*l (**Appendix 2a**). The turn-out of participants was low, with only ten participants responding to the original 45 emails sent out. The workshop was designed to gain critical insights into water governance challenges in the catchment, while also serving as a social engagement instrument with research participants. Research ethics matters were clarified at the beginning of the workshop by the project leader, and informed consent for recording and taking pictures was obtained orally. The participants were reassured that their participation in the

study was anonymous, making them more comfortable about sharing their views and experiences. Thereafter, workshop participants took turns to introduce themselves, mainly focusing on their organisations, specialisation, and interests in the water sector.

Prior to the project leader's presentation of the topic of ethics and water governance, in order to gain participants' perspectives of key issues, each participant was given stickers and were asked the following questions: i) What do ethics and value mean to you? ii) What are the main benefits you or the sector in which you work want from the water resources of the lower section of the Upper Vaal? iii) Why do you want those benefits? iv) Are these benefits currently being supplied in ways that are satisfactory to you? If not, why? The participants wrote their responses on the stickers (see **Appendix 2b**). Later, the research leader reflected on the participants' responses in a plenary session. The main intended outcome of this exercise was to gain insights into participants' understanding of ethics and values.

At the end of the first exercise, the research leader presented the purpose of the research, focusing on the distinction between ethics and values, the relationship between ethics and water governance, and ways in which ethics could potentially contribute to addressing water governance challenges in the lower section of the Upper Vaal. At the end of the presentation, participants were given room to reflect on the presentation and to ask questions for clarification. The workshop facilitated the research participants' engagement in clarifying the concept of values and ethics in the water sector and their potential contribution to the management of water resources.

The workshop participants were then divided into two groups for in-depth discussions, similar to focus group discussions which are recognised as another qualitative method for data collection.

Focus group discussions

Focus groups are defined as '*group discussions exploring a set of specific issues that are focused because the process involves some collective activity'* (Flynn *et al*., 2018, p. 1). It is a group interview of approximately six to ten people who share similar characteristics or common interests (Nyumba, 2018; Yayeh, 2021).The focus group discussions formulated in the workshop meant that participants from the workshop were the same people who participated in the focus group discussions. Workshop participants were divided into two groups, each group comprising five participants. Care was taken to ensure group diversity in terms of organisation, background, and interest.

Each group had a note taker, and one research team member who facilitated the discussion. Each group was handed plain A0 paper, stickers, and markers to write down key issues and points of discussion, and were encouraged to be creative. The facilitators guided the groups based on a predetermined set of topics, as follows: i) Water governance challenges in the study catchment (i.e., what are the water governance challenges in the catchment?), ii) Causes and effects of the challenges (What are the causes and effects of the identified water governance challenges?), iii) How such challenges might be addressed (What needs to be done to address the challenges?), iv) Possible ethical implications of the identified challenges in the catchment, v) What do ethics and value mean? (see **Appendix 2a**). The facilitators from each group created an environment that encouraged participants to share their knowledge and perceptions.

The group facilitators ensured that all the participants were involved in the discussions and each one was given an opportunity to answer the above questions. The discussions from Groups 1 and 2 were both recorded for transcription purposes. A voice recorder (TASCAM, Linear PCM recorder) was used to record the discussions with consent from the participants obtained at the beginning of the sessions.

The focus group discussions were used to gain insights into the challenges of water governance from the research participants' experiences and backgrounds. The dynamic of each group provided useful information; however, the information acquired from the focus group discussions is not valid at the individual level and is not representative of other groups. Therefore, key informant interviews were conducted to address potential shortcomings of the focus group discussions.

Key informant interviews

Interviews are the most commonly used research method in qualitative research (Lokot, 2021). For this study, they involved one-on-one, semi-structured interviews with people who had particularly informed perspectives on the water governance processes in the study area. **Table 3.1.** below details the interviews conducted, showing the interviewees' sector and speciality.

Table 3.1. Research participants interviewed showing with their sector and specialisations.

Date of interview	Sector represented	Specialisation	Interview type	Duration of interview
07/07/2020	Industry	Engineer	Zoom meeting	1 h 53 min
14/09/2020	Bulk water distributor	Water quality	Zoom meeting	1 h 13 min
18/09/2020	National government	Environmental specialist	Zoom meeting	1 h 16 min
21/12/2020	Bulk water distributor	Infrastructure maintenance	Zoom meeting	57 min
25/01/2021	Recreational	Tourism	Zoom meeting	45 min
21/01/2021	Non-Governmental Organisation, including advocacy groups	Retired engineer	Zoom meeting	1 h 37 min
24/05/2021	Wastewater treatment	Environmental specialist	Zoom meeting	47 min
22/02/2021	Higher Education	Researcher	Zoom meeting	1 h 17 min
26/01/2021	Recreational	Tourism	Zoom meeting	56 min
16/09/2021	Bulk water distributor	Water quality	Zoom meeting	37 min

Participants were selected for their first-hand knowledge about water governance processes in the catchment, and the sample size was determined using the information power as described by Malterud *et al*. (2015): '*Information power indicates that the more information the sample holds, relevant for the actual study, the lower the number of participants needed*' (Malterud *et al*., 2015, p. 1). A total of 10 interviewees was considered satisfactory because it became clear after seven to eight interview sessions that information saturation had been reached. Moreover, data obtained from other sources complemented those from the interview process.

The interview questions were structured in a way to guide the interviewee on the issues to be discussed and were sent to the participants before the interviews to allow the participant to prepare for the interview. All the interviews were conducted via Zoom platform and were automatically recorded for transcription purposes, with the consent of the interviewee. The transcriptions were sent to interviewees to check for errors and confirm that the transcription was a true representation of what was said in the interview.

The key informant interviews provided the research with an in-depth, primary source of water governance challenges because the people who participated had relevant knowledge and insight of the study.

Participant observation

Participant observation has been widely used in different disciplines as a method of collecting data about people, cultures, and processes in qualitative research (Kawulic, 2005). Participant observation was used in this study to increase the validity of the research findings from other data collection methods. It provided the researcher with a better understanding of the study context from an insider's point of view (Goico, 2021; Kawulic, 2005). Observation is defined by Marshall and Rossman (1989) as '*the systematic description of events, behaviours and artifacts in the social setting chosen for study*'.

Participant observation enabled the researcher to learn and gain more understanding of how the stakeholders went about dealing with water problems in the catchment through observing and participating in the activities which involved attending CMF meetings and participating in the catchment monitoring done by Rand Water. The forum meetings are held quarterly, during which stakeholders in the catchment meet and discuss issues concerning water resources and the governance processes. The purpose of attending the CMF meetings was to gain a better

understanding of the range of governance challenges, the values system underpinning water claims, and how stakeholders go about reconciling values when they come into conflict.

A template for attending CMFs meeting was designed as a guideline for the researcher to know what to look for in the meetings: the dominant issues that arose in the meetings, how values come into play on the ground, the interaction between the values, and verifying the issues that were discovered from other sources of data collection. The forum meetings attended were the Klip Forum meeting (4 May 2021), Blesbokspruit (6 May 2021), Leeu-Taaiboschspruit (13 May 2021), and Rietspruit (11 May 2021). These meetings were held via a Zoom meeting platform.

The catchment monitoring is done weekly by Rand Water (water quality department) and involves monitoring different activities in the catchment that may have a negative impact on the water quality of the Vaal River. Participation in catchment monitoring was done on 9 October 2021. This involved going around the catchment with water quality specialists from Rand Water and checking on the pollution hotspot areas like the pumping stations, wastewater treatment plants and water quality sampling points. Notes were taken at each place that was visited, and pictures were taken where it was necessary. Visiting the catchment and participating in the catchment monitoring activities was done to gain clear understanding of the issues that arise in the catchment from a researcher's point of view and helped to clarify some of the issues that were raised from other methods of data collection, for example, the issue of raw sewage flowing directly in the rivers in the catchment.

3.5 Thematic analysis

The data that was generated from this study was analysed using thematic analysis, as described by Braun and Clarke (2006). Thematic analysis is a qualitative technique that involves finding recurring themes in the data and creating a framework for explaining the significance of the information gathered (Lester *et al*., 2020). Thematic analysis involves organising and describing data in detail and interpreting various aspects of the research (Akinyode, 2018; Braun & Clarke, 2006). The six phases of thematic analysis as developed by Braun and Clarke (2006) and shown in **Figure 3.3.** guided the process of data analysis for this study.

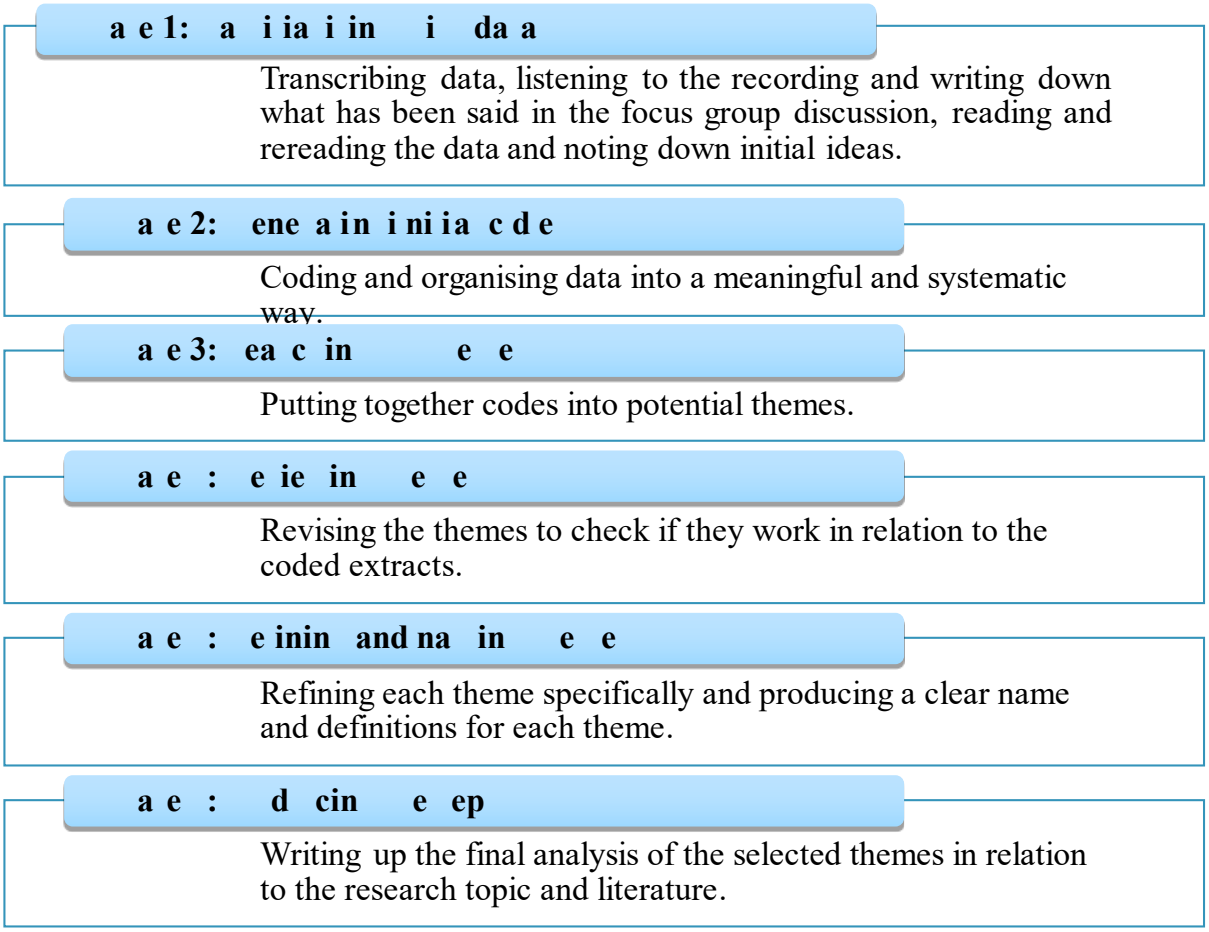

Figure 3.3 The six phases of thematic analysis developed by Braun and Clarke (2006) applied to the current study.

The first step of data analysis involved becoming familiar with the data collected from different data collection methods. The researcher familiarised herself with data from document analysis by reading through documents shown in **Appendix 1a-d**, a process that involved writing down relevant information pertaining to the research question. For key informant interviews and focus group discussions, transcribing the recorded audios was an excellent way to become familiar with the data. The researcher developed a thorough understanding of the data as the process of transcription involved listening to the audios, writing into text and going through the audios again, comparing them with the text to check for errors and mistakes.

After becoming familiar with the data, the researcher used manual coding to generate initial codes. This involved highlighting the transcriptions and notes from document analysis, and writing notes on the highlighted codes. When all the data had been initially coded and collated, the codes were sorted into potential themes and the relevant coded data gathered into the identified themes. The identified themes were then reviewed and refined, in order to group themes with the same meaning, and separated from other themes. The themes were given a title

which reflected the aspect of the information each theme captures. The final report described and reflected on the research question and literature review. Direct quotes from data finding were used to support the argument advanced.

Chapter 4: Study Area Description

4.1 Introduction

The Vaal River is the third largest river system in South Africa and is the main source of water for the Gauteng Province (Tempelhoff *et al*., 2007). Not only does the Vaal River system contribute significantly to the national Gross Domestic Product (GDP), it also provides a wide range of important ecosystem services (DWAF, 2004). These include, but are not limited to, freshwater for domestic use, agricultural water, industrial water, space for waste disposal, and sites for religious activities. However, because the main tributaries of the Vaal River, including the Klip, Suikerbosrant and Leeuspruit, drain from a heavily industrialised and urbanised catchment, the water quality of the Vaal River is compromised (Odume *et al*., 2018). Continuous pollution has resulted in water quality deterioration and has affected the ecological health of the river, negatively impacting the functionality of the river system and the people who rely on the river.

4.2 Biophysical context of the lower section of the Upper Vaal River Catchment

The Vaal River is identified as the second largest river in South Africa, with a length of about 1300 km, and covering an area of about 196 000 km^2 (Wepner *et al*., 2011). It flows from the eastern interior of the Drakensburg mountains, coming into confluence with the Orange River in the western part and eventually discharging into the Atlantic Ocean on the borders of South Africa and Namibia (Mamabolo, 2012; Tempelhof *et al*., 2007). The Vaal River falls within three water management areas (WMAs), namely, Upper Vaal, Middle Vaal, and Lower Vaal. The study area is located on the north-western (lower) part of the Upper Vaal River WMA which falls within two provinces of South Africa: Gauteng and the Free State.

The main tributaries of the Vaal River in the Upper River Catchment, include the Klip River, Suikerbosrant River, Rietspruit and Taaibospruit River (**Figure 4.1**). There are three major dams in the Upper Vaal River Catchment: the Vaal Dam, the Grootdraai, and the Sterkfontein Dam (DWAF, 2004). The lower section of the Upper Vaal Catchment area lies within C22K quaternary catchment (**Figure 4.1**). The catchment area is within the Vaal Triangle in which heavily populated and economically active towns are situated, namely, Vereeniging, Vanderbijlpark and Sasolburg (Mnisi, 2019). The Vaal Triangle is identified as a hotspot of

pollution owing to the economic activities carried out in the area which severely impact the water resources.

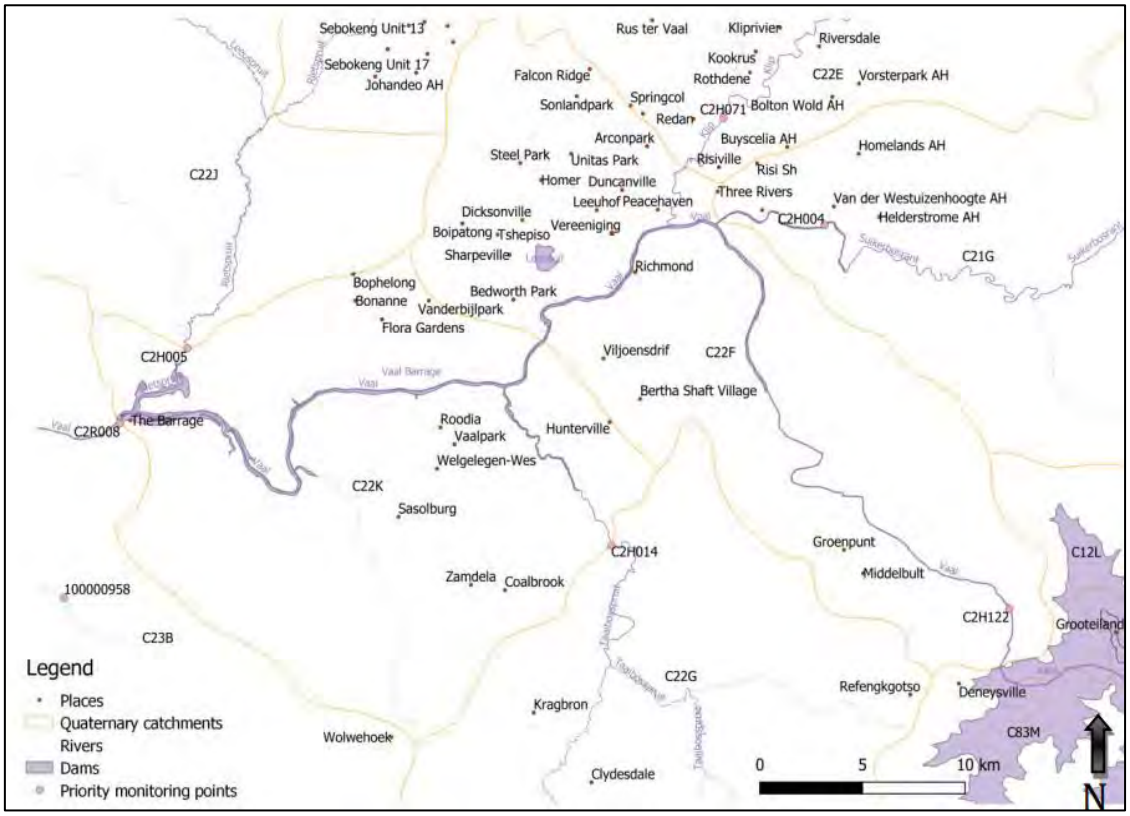

Figure 4.1. Map of the lower section of the Upper Vaal River Catchment (Source: Odume *et al*., 2022).

The Vaal Barrage Dam is susceptible to pollution owing to the tributaries that drain from a highly urbanised catchment. These tributaries include the Taaibospruit, Klip, Suikersbospruit, Leeuspruit and Blesbospruit. The lower section of the Upper River Catchment extends 63 km from the Vaal Dam and is surrounded by the towns of Sasolburg, Vanderbijlpark and Vereeniging, and townships like Sebokeng and Bophelong, which are densely populated. The study area has been divided into 10 quaternary catchments as shown in **Figure 4.1**.

4.2.1 The transboundary dimension and inter-basin transfer scheme

The water flow of the Upper Vaal River Catchment is highly modified due to inter-basin transfer schemes (IBTs). The IBTs were introduced after the first longest drought period that was experienced during the 1980s in the Gauteng region, and which put a strain on water supply (Tempelhoff *et al*., 2007). The IBT schemes are infrastructure developed and designed to

transfer water from a geographic area or catchment where it is abundant to another, different river basin suffering from water shortage (Gupta *et al*., 2008). The extended drought prompted the South African government – on the advice of environmental managers – to sign an agreement with the government of Lesotho to develop the Lesotho Highlands Water Project (LHWP) in 1986 to address the water problem in the Upper Vaal Region to sustain economic activities (Tempelhoff *et al*., 2007). Several other IBTs were developed after the LHWP – the Tugela, Heyshope and Zaaihoek water transfer schemes – which supply industries within the catchment (DWAF, 2004). The primary goal of the development of these IBTs was to address water shortages in the Upper Vaal Catchment and, specifically, to sustain economic activities such as gold mining, agriculture, and industry (Gupta & Zaag, 2008)

The transfer of water into the Vaal River system has altered both the quality and quantity of water and has had an impact on the ecosystem. Studies on the implications of IBTs have shown that the water quality of the receiving river system can either be impacted through transfer of concentrated water quality variables, such as nutrients and salinity (Fornarelli & Antenucci, 2011; Purvis & Dinar, 2020), or the concentration of the water quality variables decrease through dilution by heavy rains (Woo *et al*, 2021).

4.2.2 Climate

The climate conditions of the lower section of the Upper Vaal River Catchment were obtained by averaging the rainfall and temperature of three major cities in the catchment (Vereeniging, Sasolburg and Vanderbijlpark) for 2021. The rainfall is strongly seasonal and occurs mainly in summer (September to April), with December and January the rainfall peak months (**Figure 4.2**). The annual rainfall is 500 mm, and rainfall occurs as convectional thunderstorms, sometimes accompanied by hail. The mean annual gross evaporation (measured by Class A-pan) ranges from 1600 mm to 2200 mm (https://en.climate-data.org/africa/south-africa/gauteng/).

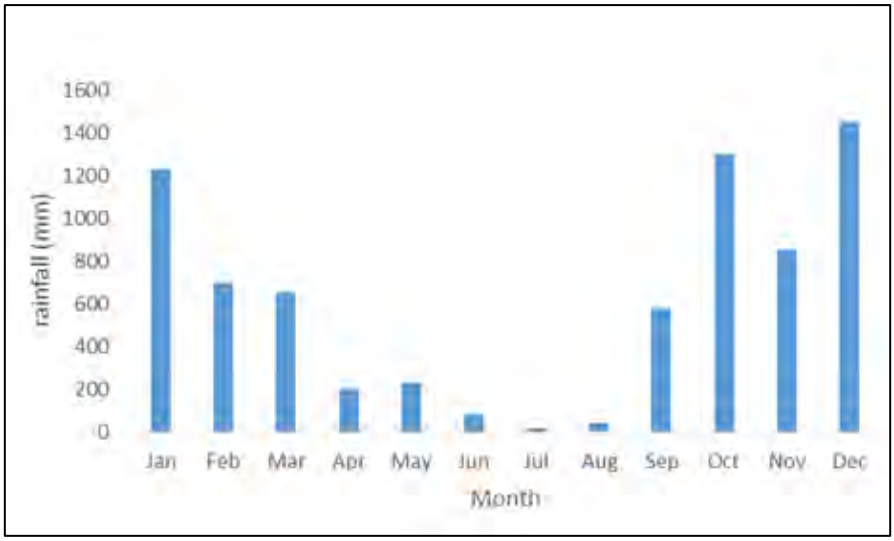

Figure 4.2. Monthly average rainfall for 2021.

Evaporation varies from high in January (ranging from 180 mm to 200 mm) to low in June (ranging from 80 mm to 110 mm). The annual temperature is 12 °C, with the highest temperatures experienced in January, and the lowest in July (**Figure 4.3)**.

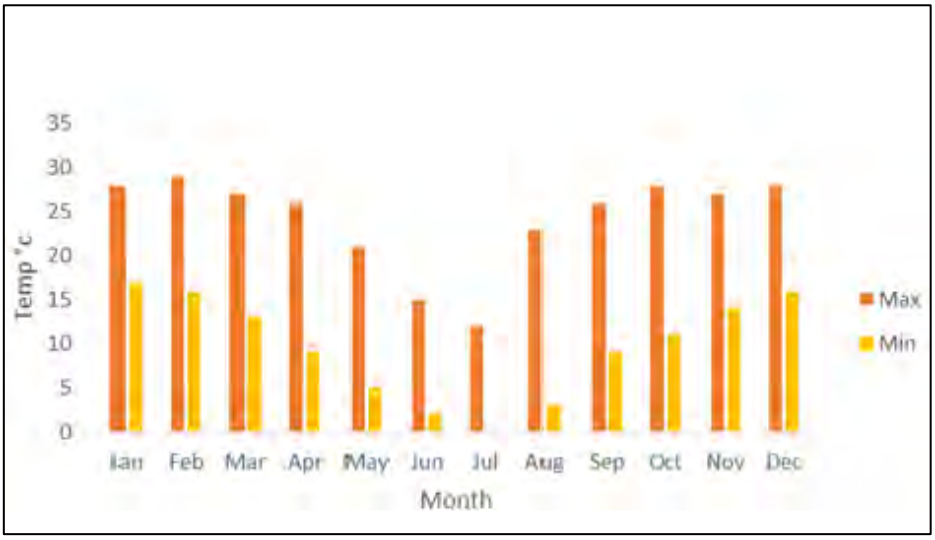

Figure 4.3 Monthly maximum and minimum average temperatures for 2021.

4.2.3 Vegetation

The Upper Vaal River Catchment is characterised by temperate and transitional forest and shrub, while northern parts have sparsely distributed vegetation, mainly dominated by savannah grassland vegetation and thorn trees, like the majestic camel thorn (DWA, 2004). The vegetation in the lower section of the Upper Vaal River Catchment is predominately Cymbopogon-Themeda veld (Ochse, 2007). The predominant alien vegetation found in the

area includes pines, acacia, eucalyptus, *Melia azedarach* (Chinaberry) and prosopis species (Ochse, 2007; DWA, 2002).

4.2.4 Topography, geology, and soils

There are no distinct topographic features in the Upper Vaal River Catchment; most of the terrain is relatively flat with an average elevation of 1,493 m. The lower section of the Upper Vaal River Catchment can be categorised as undulating plains.

The geology is complex and varies in the west and north-west parts of the Upper Vaal Catchment where the mineral deposits are found. The area also has formations of extensive dolomite. The catchment is made up of a variety of geological formations, 80% of which is Karoo system. The northern part of the catchment consists of igneous and metamorphic rocks, and the central part of dolomitic exposure (DWA, 2004). The predominant minerals are gold, coal, base metals, uranium, semi-precious stones, and industrial minerals.

The soil depths are generally moderate to deep, with an undulating relief over the entire area. There are two main soil types, clay loam and clay, which are mainly found in the Klip and Suikerbosrant catchment and to the south of the Vaal River along its central reaches.

4.3 Socio-economic context of the lower section of the Upper Vaal River Catchment

The economic activities in the Upper Vaal River Catchment have significantly influenced the demography within the catchment, especially in the lower section of the Upper Vaal where the Vaal Barrage Dam was developed. The completion of the Vaal Barrage in 1922 supported goldmining in the Witwatersrand Region, and industrial activities which stimulated economic activities and employment, leading to urban sprawl (DWA, 2004). The Vaal River supports enormous economic development within the Gauteng Province, contributing approximately 30% of South Africa's Gross Domestic Product (GDP) (DWS, 2014). The Vaal River sustains a population of more than 12 million and is considered the most important river in the country because of its significant contribution to the country's GDP (du Plessis, 2021).

4.3.1 Land use activities

The land use in the north-western part of the Upper Vaal River Catchment is characterised by industrial activities and sprawling urban areas (du Plessis, 2021). The land-use activities

include industry, agriculture, mining, electricity production (power stations), and urbanisation (DWA, 2004).

Urbanisation

Urbanisation in the Upper Vaal River Catchment is influenced by economic activities such as industry, mining, and agricultural activities (Mnisi, 2019). Mining activities in the Vaal Triangle led to urban sprawl; for example, there was a significant increase in population in Vereeniging where several coal mining activities take place. The Vereeniging population increased from 2000 residents in 1911 to 115 947 in 2015 (Mnisi, 2019). Gauteng Province is highly urbanised and, with about 24% of the South African population, and is the most densely populated province in South Africa, (SA STATS, 2016). Approximately 45% of the South African population rely on the Vaal River as a source for domestic water (drinking and sanitation) (SAHRC, 2021). The main urban settlements include Sasolburg, Vanderbijlpark and Vereeniging.

The lower section of the Upper Vaal River Catchment falls under the Sedibeng District Municipality and Emfuleni Local Municipality in the Gauteng Province (Mnisi, 2019). These municipalities are responsible for supplying potable water for drinking and sanitation, and services for wastewater treatment in local communities. More than 30 wastewater treatment works (WWTWs) deposit their effluent in the rivers within the Upper Vaal River Catchment. The WWTWs are one of the biggest point-source polluters in the catchment due to continuous failure of the treatment plants and power stations, which has caused the discharge of raw sewage or partially treated effluent into the rivers. Rand Water is a bulk water distributor, responsible for purifying water and distributing it to local municipalities, industries, and mines.

Industrial activities

The dominant land use and economic activities are production and manufacturing industries such as Sasol (oil and fuel), Iscor (steel and iron), and Eskom (power generation) (Mnisi, 2019; DWA, 2009). The industrial activities include petrochemical industries, mineral processing plants, fertiliser manufacturing, pulp and paper, steel industries, and light industry (DWAF, 2004). Sasol, which is located in Sasolburg, is one of the largest energy and chemical manufacturing industries and bulk water users in the catchment. Eskom, a power generation industry with twelve coal-fired power stations in the entire Upper Vaal River Catchment, uses water for cooling purposes and is another of the bulk water users.

Mining activities

Mining activities in the catchment are gold, coal, platinum and uranium mining (DWAF, 2002). Gold mining is located within the lower section of the Upper Vaal River Catchment, and includes the mining companies, Gold Plat, Wits Gold, Harmony Gold, and Central Rand Gold. Gold mining started on the Witwatersrand in the 1880s and has gradually become a leading source of pollution (DWA, 2011). By 1997, gold mining activities were producing 221 million tonnes of mineral waste in the Witwatersrand region (DWA, 2011).

Agricultural activities

The Vaal River system supports small- and large-scale farmers, livestock farming (cattle ranging) and crop farming, which includes maize and wheat production. Maize, wheat, and other annual crops are grown on large, irrigated areas of about 33,73% dry land cultivation in the central and south-western parts (https://water.cer.org.za/areas/upper-vaal). The Vaalharts Irrigation Scheme is recognised as one of the largest irrigation schemes in South Africa, supplying about 35 000 hectares of irrigated land, and producing mainly maize, cotton, fruit, and wheat (NAMC, 2015).

Recreational and cultural activities

The Vaal River is a popular tourist destination with several hotels, parks and resorts located on the banks of the river; these include the Suikerbosrant Nature Reserve, Riviera on Vaal Country Club, Marievale Bird Sanctuary, and Jabulani Butterfly Garden. Numerous activities take place in the area: fishing, skiing, boating and canoeing.

The river is also commonly used for cultural practices. People go to the river to perform spiritual and religious rituals, like cleansing ceremonies and baptism.

4.3.2 Water quality and pollution

Pollution and water quality deterioration is a major challenge within the catchment (Hallowes & Munnik, 2006). The social and economic activities carried out in the lower section of the Upper Vaal River Catchment have impact significantly on the water quality of the river system within the catchment. The catchment has various point sources discharging into the rivers, such as WWTWs (DWS, 2022; Ntombela et al., 2016) and acid mine drainage (AMD) purification plants from the gold and coal mines (Funke & Jacobs, 2011). The AMD purification plants are a major source of salt deposits into the rivers, mainly from defunct mines in the central and

eastern parts of the Upper Vaal River Catchment (Rand Water Annual Report, 2022). The intervention of the DWS towards mitigating the impacts of AMD in the river systems is partially addressed, this has been indicated by high saline discharges with high total dissolved salts (TDS) of more than 2 500 mg/ℓ into the rivers (Rand Water Annual Report, 2022).

Partially treated or untreated effluent discharge from the WWTWs causes microbial contamination in the river systems, such as faecal coliform and *E. coli*. The water quality reports carried out by Rand Water have shown high faecal coliforms and *E. coli* on sample points downstream of WWTWs discharge (http://www.reservoir.co.za/). The continuous discharge of effluent into rivers, irrespective of its quality, has major effects over time on the overall hydrology of the catchment.

Diffuse-source pollution is more difficult to deal with than point-source pollution. The diffuse-source pollution in the catchment is mainly runoff from urban, industrial, mining, and agricultural areas. High nutrient pollution is a challenge that comes mainly from the runoff water around the catchment (agricultural land, urban and industrial areas) which causes algal blooms resulting in eutrophication. The area is also subject to atmospheric deposition from emissions from Eskom's coal-fired power stations, and from industries in and around the catchment (DWAF, 2004).

4.3.3 Water abstraction

Water abstraction in the catchment is mainly for industrial, mining, agricultural and domestic use. Rand Water is a primary bulk water supplier, abstracting from the Vaal Dam to supply municipalities, industries and mines within the Gauteng Province, part of the Free State, Northwest and Mpumalanga provinces (Rand Water Annual Report, 2022). Rand Water abstracts an average of 4 443 Mℓ/d and during peak days, an average of 5 069 Mℓ/d, supplying 17 municipalities, 952 industries, and 27 mines (Rand Water Annual Report, 2022; SAHRC, 2021).

The Vaalharts is one of the largest irrigation schemes in South Africa and supplies water for a total of about 35 302 ha of irrigated land, of which 10% is located in the Northwest and 90% is within the Northern Cape Province (NAMC, 2015). There could be an additional 2 854 ha to supply farmers in the Taung area if the canal in the north is refurbished. Local farmers illegally abstract water for irrigation purposes in the catchment, mainly from the Liebenbergsvlei River in the eastern Free State Province, which is one of the rivers used to

transfer water from Lesotho to the Vaal Dam (Ginster *et al*., 2010). In the entire Upper Vaal, about 174 million m^3 per year was estimated to be unlawfully abstracted for irrigation purposes (Ginster *et al*., 2010).

4.4 Key water management and governance institutions

The national government (DWS) is responsible for the regulation and management of water resources in South Africa with the assistance of different institutions in the catchments. These institutions are those that interface with different water users, either potable users (individual households) or bulk water users (industries). The DWS makes use of the Catchment Management Forums (CMFs) to bring together different stakeholders who share the same interests in the management of water resources; these stakeholders include national and local government, industries, NGOs, local residents, researchers. Key water management and governance institutions that are involved in the lower section of the Upper Vaal River Catchment are described below.

4.4.1 Hierarchical institutions

The hierarchical institutions involved in water management and governance in the catchment are the national government (DWS), regional government (Catchment Management Agencies – not established or fully functional) and local governments (municipalities). The DWS is the custodian of water resources in the country and, in the absence of a CMA, in the catchment. The regional office of the DWS plays a key role in the management of water resources. In addition to its oversight and regulatory function, it is engaged in data collection, facilitating consultation, and coordinating stakeholders, as well as water quality monitoring, water use authorisation, compliance, and enforcement monitoring in the catchment. The DWS also cooperates with other government departments, like the Department of Mineral Resources, in dealing with pollution from mines.

Municipalities are the local governments that provide service delivery to the community, such as drinking water and sanitation services. The local municipalities within the catchment are the Emfuleni Local Municipality, Sedibeng District and Metsimaholo.

4.4.2 Market-based institutions

Rand Water is the largest government owned company in the country that provides bulk water to 926 industries, 40 mines, and 13 local municipalities (SAHRC, 2021). It is responsible for

bulk water abstraction, treatment, and delivery to municipalities for onward supply to residents. Rand Water plays an active role in water resources management within the catchment and is currently involved in water quality data collection and monitoring of water flow/volume within the Vaal system.

The Ekurhuleni Water Care Company (ERWAT) is a private wastewater care company that provides wastewater-related services, including conveying, treating, and disposing of treated wastewater, as well as sludges. Its activities are of critical importance due to the likely effects on the receiving river resources.

ESKOM and Sasol are the largest industries in the catchment which use significantly large volumes of water. They are actively involved in water resource management in the catchment because their operations might have severe impacts on the environment and water resources.

4.4.3 Network-based institutions

The water user associations (WUA) and catchment management forums (CMFs) are platforms used to bring together stakeholders within a catchment area to discuss water related issues and concerns The CMFs are recognised to play an important role in the establishment of catchment management agencies (CMAs). In this study the CMFs are identified as participatory vehicle in water governance, whereby citizens and other stakeholders can participate in decision making processes. Active CMFs within the broader lower section of the Upper Vaal include the Blesbokspruit, Klip, Leeu-Taaiboschspruit and Rietspruit (https://www.reservoir.co.za).

Within the Upper Vaal River catchment, critical non-governmental, organised institutions exist through which civil society and citizens play active role in water resources governance. Critical among these institutions are the Save the Vaal Environment, and the Vaal Action Group. Both organisations have similar aims, which are to protect the Vaal River system, raise awareness about the danger of pollution, and mobilise citizens to hold government to account through the instrument of the law. The Save the Vaal Environment organised itself as a non-profit organisation (NPO), whereas the Vaal Action Group is an association of volunteers.

4.5 Key water management instruments in the catchment

The source-directed control (SDC) and resource direct measures (RDMs) are Integrated Water Resources Management (IWRM) tools that are implemented in South Africa to ensure water resources protection (Odume *et al*., 2018). The SDC is the primary measure implemented in

the catchment to control the usage and protection of water resources. The water user licence (WUL) is one of the SDC instruments that is compulsorily imposed on all water resource users (either abstraction or discharge) within the catchment to control water usage and protect water resources (Odume *et al*., 2018). Water quality licensing (WQL) is another SDC instrument that is used to control activities (for example, industrial and mining activities) that are likely to impact water resource quality, in which the licence specifies the standards of water quality parameters that must be complied with (Odume *et al*., 2018). The information contained in the WQL covers the volume of waste discharge, discharge regime, standard of effluent discharge, frequency of monitoring, and other specifications determined by activities carried out (DWAF, 2007). The conditions of WQL are aimed at restricting the impacts of pollution on the receiving water resources, ensuring sustainable water resources within the catchment for social, economic, and ecological purposes.

The RDMs define the appropriate level of protection for water resources and set RQOs to ensure resource quality. In cases where operations start before a WUL is granted, the water users are required to implement the RQOs as measures to control their activities. The RQOs determine the quantity and quality of the water resource (Odume *et al*., 2018). The RDMs that are implemented in the catchment include, monitoring of instream water quality, catchment monitoring and surveys, and reinforcing compliance through the use of, for example, the polluter pay principle. The Green Drop Programme is an incentive-based method that was introduced to regulate the quality of WWTW effluent through motivation and reward; it is aimed at improving the wastewater management in the country by identifying areas that require development and improvement (Ntombela *et al*., 2016).

Chapter 5: Analysing Water Governance Challenges and their Ethical Dimensions in the Lower Section of the Upper Vaal River Catchment

5.1 Introduction

The world water crisis has been identified as being primarily caused by mismanagement of water resources and systemic water governance failure (Akhmouch *et al*., 2018; Nastar, 2014). Water governance has emerged as an important topic across the world (Stefanovic & Adeel, 2021) and has been acknowledged as crucial for the sustainable management of water resources (Jiménez *et al*., 2020; Özerol *et al*., 2018). Strengthening water governance has been identified as a top priority for action to achieve sustainable water resources. Improving and strengthening good water governance can contribute to addressing key water-related challenges such as pollution, collapse of infrastructure, and distributive equity, all of which impact on water security (Araral & Wang, 2013; Taylor *et al*., 2019).

The South African water legislation (NWA, 1998) advocates for inclusiveness and the participation of citizens to achieve sustainable, equitable and efficient management of water resources. Sustainability, equity, and efficiency are recognised as fundamental values of good water governance in the South African water sector. These values are enshrined in the NWA of 1998 as key principles that guide the use, management, and governance of water resources in the country. These three values are not met due to systemic water governance challenges that confront the South African water sector. South Africa's water problems reflect the challenges in managing complex natural resources with competing water users who have different objectives (Muller, 2012). In a national review study, Weston and Goga (2016) identified three top water governance challenges confronting South Africa: lack of accountability, ineffective implementation of regulatory measures, and poor cooperative governance.

These water governance challenges have manifested in the lower section of the Upper Vaal River Catchment. Pollution is a major challenge and has been linked to poor implementation of the regulatory system. The Vaal River is one of the largest and most impacted rivers in South Africa, mostly due to anthropogenic activities in the catchment (Tempelhoff *et al*., 2019). The area is distinctively identified as the 'economic heartland' of the country as it contributes 30%

GDP to the economy (Nieuwoudt *et al*., 2004). However, poor water governance practices have led to the deterioration of water quality in the river systems within the catchment (Hallowes & Munnik, 2006; Tempelhoff *et al*., 2007). Deterioration of water quality in the Vaal River poses a great threat to the country's economy, to current and future generations, and to the ecological health and functionality of the ecosystems.

The challenges flowing from systemic water governance failures have ethical implications for both social and ecological systems. The challenge of ineffective implementation of the regulatory measures has negative impacts for ecosystem services derived from the river and for ecological health and functionality. In this regard, there is a growing body of knowledge advocating for the management of water resources in the context of SES in South Africa (de Wet & Odume, 2019; Odume & Wet, 2016; Pegram *et al*., 2006). The interaction of the SES components is complex and requires careful balancing and trading-off when it comes to decision and policy making. Ethics has been identified to help intervene in the interactions between the components of the SES (Amir *et al*., 2021; Stefanovic & Adeel, 2021). In the field of environmental ethics, systemic-relation ethics is recognised to be advanced in addressing and intervening in the interaction of the SES components. The components of the SES are recognised in an ongoing and interconnected relationship (de Wet & Odume, 2019; Odume & de Wet, 2019). Adopting the SR ethics in water governance can contribute to sustainable management of water resources by explicitly reflecting the implications of the trade-off the components of the SES, as well as recognizing that the components of the SES are inseparable and should thus receive equal attention and treatment in the decision-making processes.

Despite the contribution ethics can bring to water governance, it is still a relatively new field of study in the South African water sector (Odume *et al*., 2022). The current study intends to contribute to the value of an ethics approach by exploring the ethical dimensions of water governance challenges in the lower section of the Upper Vaal River Catchment. It is argued that by paying attention to ethics it is possible to reflect on the morality more deeply, and on the practical and policy implications of these challenges precisely by drawing an ethical framework that sees the SES as mutually constitutive. This chapter fulfils the first objective of the current study as stated in **Chapter 1**, Section **1.2.**

5.2 Materials and methods

5.2.1 Sampling strategy

The study used purposive sampling in the selection of the participants, for the reasons explained in **Chapter 3**, **Section 3.3**. The participants who were targeted are those who work in the key water institutions in the catchment. The selection of participants involved a background check of the experience and knowledge of stakeholders in the water governance processes in the catchment. The background check was carried out by analysing forum minutes and looking for stakeholders who actively participate in the CMFs. Their experience and knowledge in the water governance processes was a major consideration in the selection process. The demography of participants in the key informant interviews is fully elaborated in **Chapter 3** (**Table 3.1**). Purposive sampling was useful for this study in gaining a deep understanding of issues pertaining to water resources management, governance, and challenges within the catchment.

The snowballing sampling method was used, whereby participants recommended and referred the researcher to other stakeholders in the catchment who had experience and extensive knowledge of water governance issues.

5.2.2 Data collection

The study used a combination of different methods of data collection, and the data sources involved both secondary and primary data. Secondary data collection involved analysing documents, and primary data collection involved a workshop, focus group discussions, key informant interviews and participant observation. The findings from these data collection methods were triangulated for validation to gain the breadth and depth of water governance processes and challenges in the catchment. **Chapter 3**, **Section 3.5** of this study explains in detail the methods of data collection**.**

Document analysis

Document analysis involved the review of CMF minutes, reports (from government, media), published research articles, and research theses (**Appendix 1a-d**). The key search words included ‘water governance’, ‘water management’, ‘water governance challenges’, all focusing on the lower section of the Upper Vaal River Catchment. The purpose of reviewing relevant

documents for the study area was to gain an historical perspective of current issues pertaining to water governance. The information that was retrieved from CMF minutes covers a period of two decades (2002–2021), which was useful for this study as it showed trends on the issues of water resources, recurring, unresolved and cumulative issues in the study area.

Workshop

A workshop was conducted in the catchment on 21 August 2019 at Sarabi Lodge to gain further perspectives into dominant values underpinning water governance and key water governance challenges in the lower section of the Upper Vaal River Catchment. Ten participants attended, mainly from the Department of Water and Sanitation, Rand Water, the private sector, academic institutions, and NGOs.

The workshop was designed to encourage participants to engage in an open-minded discussion and to freely express their knowledge and experience on the subject under research. The participants elaborated on their understanding of ethics and values, defining the two terms based on their own understanding. The participants were further engaged on the issue of the benefits they derive, or intend to derive, from the water resources within the catchment. The purpose of engaging with the participants on the benefits was to have an overview of values that dominate and were likely to influence water governance in the catchment.

Focus group discussions

The workshop participants were divided into two groups of five people in each group. Care was taken in dividing the participants to ensure group diversity in terms of organisation, background, and interests. In each group a member from the research team played the role of facilitator, ensuring that each participant could contribute equally to the discussion. These discussions were conducted to gain a deeper understanding of the water governance challenges within the catchment.

Key informant interviews

Semi-structured questions were used to guide the participants on the subject whilst allowing them to freely express their knowledge and experience. The purpose of conducting key informant interviews was to gain an in-depth understanding of water resources governance, management, uses and challenges. A total of 10 interviews were conducted via Zoom platform and recorded on the laptop with the consent of the participants. The number of interviews (sample size) was determined using '*information power'* (Malterud *et al*., 2015). The

information that was gained from each interview was relevant for the study owing to the vast knowledge and experience of the participants, therefore, determining the number of interviews conducted.

Participant observation

Participant observation enabled the researcher to validate the issues raised by other methods of data collection by taking the role as a participant observer at CMF meetings of the Vaal Barrage and participating in one of the catchment monitoring surveys conducted by Rand Water on 9 October 2021. The observation was guided by a template consisting of predefined questions of concerns that were raised through stakeholder engagement, that is, the workshop, focus groups discussions and interviews. Field notes were taken in a notebook and photographs were taken where it was necessary.

5.2.3 Data analysis

Thematic analysis

Thematic analysis was used to analyse data from the qualitative methods of data collection following the six phases developed by Braun and Clarke (2006). The steps taken in analysing the data collected are fully described in **Chapter 3**, **Section 3.6.1.** The findings were presented in themes of recurring water governance challenges.

5.3 Results

5.3.1 Stakeholders' understanding and perception of ethics and values

Ethics and values could have different meanings for different people, as exemplified by the responses from the workshop participants, which showed a divergent understanding of the meaning of ethics and values. One of the participants mentioned that ethics meant, *'honourable behaviour',* while another participant said it meant *'right or wrong'*. Regarding values, one of the participants mentioned that it meant, *'what we consider right or wrong',* and another participant said it meant *'honesty'*. **Table 5.1** shows the multivariate meaning of ethics and values from participants' responses. What these divergent interpretations of ethics and values imply is the need to clarify what these terms imply in order to arrive at a common understanding and interpretation. In this study, ethics was taken to mean '*a systematic concern with the principles by which conduct, morals and values are clarified and justified, as we seek to distinguish between right and wrong in our behaviour towards other people and towards*

nature', and values as, *'[what] specific societal groups or constituencies express at a generalized level to be good or bad'* (Odume *et al*., 2022, p.2).

Table 5.1. Interpretation of ethics and value by workshop participants.

Ethics	Values
▪ Accountable, responsible and having integrity ▪ Honourable behaviour ▪ Doing the right thing even if it goes beyond laws and relations ▪ Behaviour based on values ▪ To do the right thing ▪ Principles that help us distinguish between right or wrong	▪ What we consider right or wrong ▪ Morals and principles ▪ Principles that one lives by and interacts with other people ▪ Integrity ▪ Excellence ▪ Honesty

5.3.2 Identified water governance challenges in the lower section of the Upper Vaal River Catchment

Analysis of the data revealed five primary water governance challenges in the study area, namely i) failure in the implementation of water legislation and regulations, ii) ineffective leadership and management, iii) cooperative governance and poor accountability, iv) decentralisation and ineffective participation, and v) finance, infrastructure, and technical capacity.

Failure in the implementation of water legislation and regulations

The South African National Water Act, No 36 of 1998 (RSA, 1998) has been hailed as a blueprint as it gives rights to both the ecosystem and basic human needs. However, the implementation of water legislation has been only partially successful (Tempelhoff *et al.*, 2019). Analysis of the data of the current study suggests that participants were concerned about the implementation challenges being experienced in the catchment. The participants from the workshop and the key informants raised the issue of partial or complete failure in implementing the water legislation as an impediment to sustainable and equitable management of water resources in South Africa. With reference to the lower section of the Upper Vaal River Catchment, some of the participants indicated that:

The problem is taking action; we've got fantastic legislation, a great Act but implementation in South African context is very difficult (Interview).

If you look at the Act, for an example, on paper the National Water Act is more like a blueprint because it speaks to the government structure, multi-layer government structure where you have Catchment Management Forums, Catchment Management Agencies, and water user associations (water boards) which are locally based and driven but implementation has been a challenge (Focus group discussion).

An efficient licensing system is crucial for effective, sustainable management of water resources through equitable allocation and pollution control. The failure to implement the regulatory system is another challenge that has manifested in the catchment, which involves authorisation of water use and regulation of wastewater discharge. Inefficient implementation of the wastewater discharge regulations has led to multiple incidents of illegal discharges (industrial and mining activities) into the river. There are ongoing pollution incidents in the catchment which have impacted the water quality and ecological health of the water resources, and yet little has been done to eliminate these pollution incidents. The regulatory measures are available (authorisation licensing and enforcement of compliance), but the issue remains – the lack of effective implementation of these regulatory measures. One of the participants from the focus group discussion indicated that the regulatory measures are not effectively implemented:

We have many regulations, but they are not implemented, they just do the surface stuff, but the deeper stuff they are not doing (Focus group discussion).

Another key informant raised the concern of the ineffective implementation of the regulatory system/s that are put in place in the management of water resources. The participant indicated that:

There is lots of challenges always, but there are systems that are in place, they might not be as effective, but systems are in place to address these issues (Interview).

The Department of Water and Sanitation is in charge of monitoring compliance and authorising water use, but currently there are multiple challenges related to the water user licensing application process in the Department. There is a persistent delay in the process of issuing of water use licenses (WULs) owing to the backlog of past applications. This has resulted in industries and mines operating without WULs, and several farmers in the catchment unlawfully abstracting water for irrigation. This unlawful irrigation in the catchment (Axle and

Leibenbergsvlei water transfer scheme) results in over-abstraction of water from the river system (Ginster *et al*., 2010), which impacts the flow of the river:

> *The most recent estimate by water resource planners of the use of water in the entire Upper Vaal Region 3 is that about 174 million m3/annum is unlawfully used for irrigation purposes* (Ginster *et al*., 2010, p. 2).

The unlawful abstraction of water in the catchment has been raised as a concern by participants in the study. One of the key informants mentioned:

> *It's so much bluntly unlawful water use; if you don't have WUL or right and you are bluntly irrigating* (Interview).

Ineffective leadership and management

Leadership is among the seven elements that were identified as affecting performance of governance in the water sector (Berg, 2016). Leadership is construed as the ability of an individual or group of individuals to influence and guide followers or other members of an organisation. Leadership plays a role in setting the stage for developing and implementing sustainable management practices (Bhaduri *et al*., 2013). The failure of leadership in the water sector results in the poor performance and failure of the whole organisation or institution, and of all the systems involved in water governance processes. Ineffective leadership in the national government departments was raised as a major challenge that has significantly affected the management of water resources in the catchment. The participants from the workshop argued that the people who are in positions of leadership are ultimately responsible for the failure of the people who are below them. One of the participants explained:

> *When both the top echelons are failing, it means that down there it becomes a vacuum because the juniors, if they are not getting support, will struggle to do the work as they are supposed to* (Focus group discussion).

The managerial team is the key driver of the department's mandate, which can only be achieved by effective leadership steering the organisation in the right direction. The issue of inexperienced and unskilled personnel was stressed as a challenge throughout the water sector, especially in leadership and management positions. One of the participants stressed:

> *The top managerial people do not know what to do; how do we expect the people from the bottom to know?* (Interview).

The government departments are endeavouring to manage the water resources, but failure of the top managerial people results in the failure of the whole team, as indicated by the participants. Effective leadership and management can provide a direction to effective water governance and effective implementation of regulatory measures.

Cooperative governance and lack of accountability

According to the principles of cooperative governance, the various government departments across tiers should work together in a mutual and co-supportive relationship (NWA, 1993, Chapter 3). However, the failure in cooperative governance has been recognised as one of the top water governance challenges in South Africa and has resulted in a lack of accountability between the government department due to unclear roles (Weston & Goga, 2016). Although the Intergovernmental Relations Framework Act, Chapter 3, Act No. 35, provides for structures and institutions that promote and facilitate intergovernmental relations, cooperation and accountability mechanisms between the various government structures, departments and tiers of government is poor. The most notable example of the poor accountability mechanism is the failure of the Department of Water and Sanitation to hold municipalities to account, especially when municipalities release poorly treated wastewater into the receiving environment. In particular, the research participants were concerned that intergovernmental relations and communication were poor, as indicated in a focus group discussions:

> *The different government departments do not work together because they see working together as interference when other departments come to help, especially amongst the ministers* (Focus group discussion).

The assertion above seems to suggest that cooperative governance is a principle only, but not a practice. As an example, the catchment is currently facing the challenge of Acid Mine Drainage (AMD), a legacy of old mines. Mining falls within the jurisdiction of the Department of Mineral Resources (DMR) in South Africa, but in trying to mitigate the effects of AMD on water resources, the DWS has received little cooperation from the DMR. This example of cooperative governance failure was highlighted by one of the interviewees:

> *The Department of Mineral Resources has not been so cooperative as were hoping them to be where they've made our work quite difficult because they are not responsive whenever we engage them. They have not been very helpful in so many ways and it is a big thorn that DWS is going to work very hard to try and fix because we feel that it is an industry that or sector that, if we are not firmly able to make sure that we take them*

to account, it's going to actually put the DWS in a situation where now, like for instance [the]AMD problem, we had to address it on our own (Interview).

The above assertion raises the issue of accountability, in which the Department of Mineral Resources is not holding mining companies accountable and is refusing to engage cooperatively to deal with the Department of Water and Sanitation on the issue of AMD. This is a serious challenge as poor water quality in the catchment from AMD has become a critical concern. Poor intergovernmental relations between these two departments have also resulted in many cases in which mining companies get their mining license before getting a WUL, resulting in serious issues of compliance in terms of management of mine water. Participants from one of the focus group discussions raised this as a serious concern in the sustainable management of water resources. The participant indicated that:

A lack of coordination and cooperation in different departments, specifically, there are lots of issues with mining and water. They get mining rights before they get water licence and it's a big issue (Focus group discussions).

Poor cooperative governance has proved to be a hindrance to sustainable management of water resources, especially in the catchment where municipalities continue to pollute the rivers with recurring and ongoing incidences of raw sewage pollution. According to the conduct of intergovernmental relations, the national government (DWS) is obliged to assist and support the local governments (municipalities) (IGR Framework Act, 2005). In this regard, the DWS cannot take legal action against the municipalities, which has led to municipalities not being accountable for the raw sewage pollution of the catchment that they have caused and are continuing to cause. One of the participants from the study referred to cooperative governance as a hindrance for the municipality to take accountability of their sewage pollution happening in the catchment:

Cooperative governance is the hindrance to a lot of these issues that are taking place because government won't take government to court. The Department [DWS] have never taken any local authority to court and foster an action on them to actually get something resolved (Interview).

Raw sewage has been identified as the major water quality challenge in the catchment, yet little is being done to hold the municipalities accountable. Participants from the focus group discussions shared their grievances and concerns on the matter of the ongoing raw sewage pollution. They indicated that the DWS acts when it comes to pollution incidents caused by

industries and other private companies, but when it comes to municipalities, no action is taken against them. One of the participants from the interviews mentioned:

> *Municipalities, such as Emfuleni Local Municipality, are the biggest polluters, but they are never held accountable. The Department [DWS] keeps hammering the private sector for pollution but does nothing when it comes to municipalities* (Interview).

Decentralisation and ineffective participation

Decentralisation, devolution and greater participation of communities in water governance (Cook & Bakker, 2012) are fundamental to sustainable and equitable management of water resources. Collaborative approaches in water governance have been promoted as a means of enabling participation in environmental decision-making (Margerum & Robinson, 2015). The South African National Water Act of 1998 emphasises the decentralisation of water resource management to catchment level through the establishment of CMAs, and transformation of governance from a top-down form of governance to a more inclusive and participatory governance. The CMAs were to be established in each of the 19 WMAs around South Africa, a number that was later reduced to nine CMAs due implementation challenges (Weston & Goga, 2016). To date, only two CMAs (Inkomati-Usuthu and Breede Gourtz) have been established since the enactment of the NWA, 1998. CMFs play the role of non-statutory forums to the establishment of the CMAs and these forums facilitate public participation in the management of water resources.

Decentralisation has been recognised to be effective when it comes to dealing with problems that are locally based, for example pollution caused by social and economic activities (Cook & Bakker, 2012; Erdiaw-kwasie *et al*., 2020; Lee *et al*., 2022). The delay in the establishment of the CMA has contributed to the challenge of ongoing pollution incidents in the lower section of the Upper Vaal River Catchment. The data analysis showed that the delay in the establishment of the Upper Vaal CMA is referred to as the cause of several water challenges in the catchment by the DWS. The NWA, 1998 provides for the delegation of water resource management function to regional level in order to address issues which are specifically relevant to the area. One of the participants from the interviews mentioned that:

> *When people put the Department of Water and Sanitation [DWS] on the spotlight [sic] about what they are doing and why they are not fixing the problems, they always say, Once we have the catchment management agency [CMA], we are going to fix everything* (Interview).

The delay in establishing the Vaal CMA has resulted in non-devolution of power to the catchment level in terms of water resource management. However, there is controversy amongst stakeholders in the Vaal Catchment about whether the establishment of the CMA will solve the current water problems or possibly worsen them. Participants from the focus group discussions raised the issue of an increased government layer which may result in more accountability problems and bureaucracy. One of the participants further protested the incompetence of people who are currently working in the government department, and yet those same people would be working in the CMAs:

> *I don't know how it's going to work; the CMA is going to be populated by the same inefficient people who are working in the Department [DWS]* (Interview).

The NWA 1998 places participation and stakeholder engagement as key values that should drive the management of water resources to desirable state. The CMFs are an example of water management institutions that foster public participation and stakeholder engagement in South Africa. The question arises about whether these CMFs are effective in achieving participatory water governance. Participants from key informant interviews and focus group discussions have argued that the CMFs are not effective due to poor attendance by local governments and national government departments. Attendees are those from the lower levels in the institutional hierarchy and are not able to make informed decisions. Therefore, the CMFs are not effective when it comes to decisions about management of the water resources. One of the participants referred to CMFs as *'talk shows'* in the sense that no informed decisions are implemented by government, hence stakeholders meet to discuss problems and nothing of significance comes out:

> *You have people attending the forums from the Department that are unable to take accountability for the decisions that are made or actually have responsibility to make decisions at forum meeting. So, in other words forums just end up in talk shows* (Interview).

Another participant raised the issue of local government officials not attending the forum meeting and their lack of commitment:

> *At Rietspruit Forum our main problem at the moment is with municipality, they don't attend the meeting…, now it's a Zoom meeting and there is no excuse, the more senior management do not even leave the office just to switch on the computer and be part of*

the meeting. There are not even there to acknowledge the problems and tell us what they intend to do (Interview).

Finance, infrastructure, and technical capacity

Finance, infrastructure, and technical capacity are essential to maintain and achieve short- and long-term sustainable management of water resources. Financial resources are crucial for implementing measures, for example, infrastructure, and human capacity in the water sector (Hilbig & Rudolph, 2019). The way water and wastewater infrastructure are designed, or built and operated is influenced by the availability of financial resources, which impacts on their functionality. There was a general perception on the part of the study participants that poor management in government departments was a key contributor to observed challenges within the water sector; for example, poor financial management in the national and local governments. Participants from the focus group discussions emphasised this issue, where sometimes, financial resources that have been allocated to infrastructure are diverted to other activities:

> *Government gives municipalities the Municipality Infrastructure Grant (MIG) and what happens is that some of the money gets reallocated to something else which is not about that infrastructure investment* (Focus group discussions).

Mismanagement of finances in the national government department is a further major challenge in the country. The DWS reported R1.8 billion in irregular expenditure and R13 million on fruitless and wasteful expenditure in the annual report (DWS, 2019). The mismanagement of financial resources has negatively impacted the maintenance of infrastructure in the water sector. The Rand Water CEO, Sipho Mosai, mentioned that the ability of the company to upgrade and maintain its infrastructure has been significantly affected by non-paying municipalities (Patrick, 2022). The cycle of building, maintaining and operating infrastructure is a continuous process which requires stable inflow of finances, and the failure of the municipalities to pay their bills has significantly affected Rand Water. It has been reported that the Gauteng local municipalities currently owe an amount of R5.3 billion to Rand Water (Mahlati, 2022). Regarding financial governance, one of the participants from the interviewees argued:

> *What happens is, when eventually there is some money that becomes available to fix the works, the money is just generally enough to fix one component and you see the municipalities [do] the easiest things, like fencing, and not actually fixing what needs*

to be fixed in the wastewater works because the plant can't be fixed with one small portion of it; the entire system needs to be fixed (Interview).

Technical capacity is essential to achieve sustainable management of water resources, and technical capacity is one of the Organisation for Economic Cooperation and Development OECD) principles which has been identified as essential to effectively implement good water governance practices. Inadequate technical capacity (lack of skilled personnel and engineers) has been identified as a challenge in the catchment. Participants raised the issue of the local municipalities' failure to secure a skilled workforce, and this has been linked to corruption and political interference when hiring. Unver (2008) referred to corruption as a '*cancer*' with the view that it is difficult to deal with and will require removing people who are benefiting from it. The provision of water services and the achievement of equitable and sustainable development are now both considered as dependent on anti-corruption activities (Neef *et al.*, 2009).

The national and local governments have the challenge of securing highly qualified staff over a consistent period of time, and leadership positions are normally given to people with political patronage who corruptly hire relatives (Mbandlwa, 2020); thus, managerial positions end up with people who do not have the skills or adequate knowledge. The political appointees do not stay in the position for long, and accountability becomes a challenge in the government department. The post-apartheid ministers of Water and Sanitation have been changing after a period of 3-4 years in the position, leading to an issue of accountability as the newly appointed minister deals with the problems that previous minister/s left behind. The current minister is dealing with the problems of infrastructure failure, the result of neglect for the past two to three decades. This issue was raised in the focus group discussions as a huge concern in the challenge of pollution. One of the participants indicated:

The main challenge is the governance of those water boards; as long as we have the political appointees who do not understand the effect of water pollution does to the next generation because they push their mandate for a period of 5/2 years and they are gone. They are not sustainable 'cause after two years they are gone. Whatever comes to the next minister it's their own business (Focus group discussions).

Integrity and transparency are among the OECD principles which are critical in building trust and influence in stakeholder engagement (Akhmouch & Correia, 2016). Lack of transparency in the national and local governments has been raised as a challenge in South Africa due to

corruption, especially on the issue of tenders. Participants stressed that the people who access tenders for infrastructure development have connections with the top leadership, not necessarily because they are capable of delivering quality services. This has affected the efficient and sustainable development of water and sanitation infrastructure. Participants from the focus group discussions raised this as a concern and a barrier to sustainable infrastructure development; one of the participants said:

> *My problem is that those who are pushing tenders, they are just too happy that someone is going to tender a friend, or a colleague and they are going to get their cut. Simply, they do not care about right infrastructure for sustainability* (Focus group discussions).

5.3.3 Deterioration of water quality in the lower section of the Upper Vaal River Catchment as a consequence of systemic water governance failure

Water quality is a serious concern in the catchment and so water quality and pollution incidents reports dominate the meetings and minutes of the Vaal Barrage CMFs. Several sources of pollution have contributed to the deterioration of the water quality in the Vaal River system: industrial pollution, mining activities, agricultural activities, raw sewage pollution from municipalities wastewater treatment works. Recurring issues of illegal discharge in the river system have resulted in the deterioration of the water quality which, in a way, is as a result of ineffective implementation of regulatory measures and compliance enforcement. Several water quality problems have been reported in the CMFs (Leeu-Taaiboschspruit, Klip and Blesbokspruit) for a period of nineteen years (**Figure 5.2)**. Although the number of reported water quality problems presented in the figure might not show the actual numbers, due to poor attendance and lack of consistent participation on the part of stakeholders in the CMFs, it provides a general overview of the predominant water quality issues in the catchment.

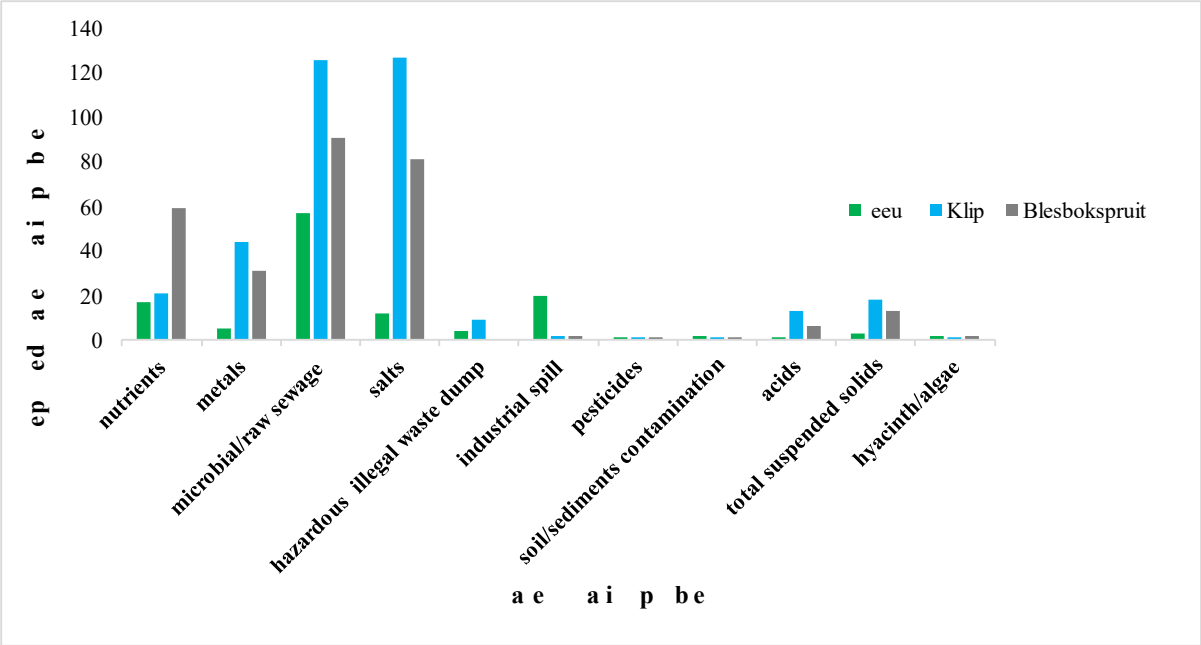

Figure 5.1. Frequency of water quality problems reported in the Leeu-Taaiboschspruit, Klip and Blesbokspruit Catchment Management Forums from 2002–2021 (Source: http://www.reservoir.co.za/).

These water quality problems are linked to systemic water governance failure and failure to implement the regulatory measures.

5.3.4 Ethical implications of the identified water governance challenges

Drawing on the ethical framework given in **Chapter 3, Section 3.2**, the study reflects on the ethical dimensions of the water governance challenges. The challenges of water governance and failure in the governance system affect both the social and ecological systems, raising ethical issues regarding protection of the environment and human needs. When it comes to distributive equity in the management of water resources, the social aspect tends to receive more attention than the ecological aspect. The ethical framework outlines equitable treatment of the SES components in management and decision-making of water resources, and water governance practices and systems must support and recognise the relationship between humans and their environment in a more sustainable way. The ethical implications of the identified water governance challenges are elaborated in **Table 5.2**.

Table 5.2. Ethical implications of the identified water governance challenges in the lower section of the Upper Vaal River Catchment.

Challenge 1: Failure in the implementation of water legislation and regulations
▪ The South African National Water Act of 1998 recognises the social (Basic Human Needs Reserve) and ecological (Ecological Reserve) components in the management, use and protection of water resources. The challenge is the effective implementation of the NWA, which has negatively impacted realising the environmental value of and sustaining ecosystem functioning. ▪ The failure of implementing regulatory measures raises the issue of distributive equity between different water users and the ecological system. The operation of several industries and mines without a WUL potentially impacts the ecological system by discharging effluent that over-spikes the RQOs of the receiving water resource. ▪ The costs of pollution incidents have affected other water users who are not responsible for the pollution. For example, raw water abstractors like Rand Water no longer abstract from the Vaal Barrage Dam owing to pollution and deteriorating water quality. Tourism activities have decreased significantly owing to pollution in the Vaal River and the catchment. ▪ Pollution impacts transboundary responsibilities. In the case of the Upper Vaal River Catchment, pollution affects downstream water users in the Mid-Vaal, Lower-Vaal and Orange River who receive contaminated water. ▪ Illegal abstraction of water in the catchment caused by farmers operating in the catchment without a WUL. This overexploitation of water resources affects the functionality of the ecological system and impairs fair distribution of water resources between different water users. ▪ Equitable treatment of SES components is impaired due to the failure to implement the regulatory system. Several ongoing incidents of poor discharge of effluent from the local WWTWs have had negative impacts on ecological health.
Challenge 2: Ineffective leadership and managerial team
▪ Ineffective leadership in the DWS hinders the Department from driving their mandate, which is to ensure that the country's water resources are protected,

managed, used, developed, preserved and controlled. In this regard, responsible use of water resources and equitable treatment is impaired due to poor decision making.

Challenge 3: Cooperative governance and lack of accountability

- The challenges in practising and implementing cooperative governance have resulted in unclear roles between the municipalities and the DWS. Unclear roles affect the resolution of problems such as the ongoing sewage pollution in the catchment; the stakeholders do not know who to contact when a problem arises. This has resulted in problems taking a long time to be resolved with significant implications for social-ecological systems within the catchment.
- Poor cooperative governance has led to poor accountability whether vertically or horizontally. For example, the DWS is unable to effectively hold local governments to account when they pollute, and this has impacted on equitable access to water resources within the catchment, raising serious ethical concerns. Strengthening cooperative governance that leads to heighten levels of accountability can redress these inequities.
- Ongoing sewage pollution has health implications for the citizens who come into contact with the water, for example, people who use the river for cultural practices and go into the river for cleansing purpose. The AMD and raw sewage pollution affect the ecological health of the watercourses.

Challenge 4: Decentralisation, and ineffective participation

- Delay in establishing CMAs (decentralisation of water resources to catchment area) has impaired the effectiveness of the CMFs and citizens (stakeholder engagement and public) to influence in decision making.
- Delay in the decentralisation of water resource management has impacted issues that need to be addressed at catchment level, like the distribution of water resources amongst different water users (abstractors and dischargers).

Challenge 5: Finances, infrastructure, and technical capacity

- Mismanagement of finances has ethical implications because citizens do not get the proper service delivery they are paying for.

- Poor technical capacity and failure of infrastructure in the local municipalities has contributed to the failure of sewage systems, causing severe raw sewage pollution in the catchment and river systems and health risks for the citizens. Impoverished communities suffer from the costs of raw sewage.
- There is social injustice in terms of costs and benefits distribution amongst communities; the high-density suburbs suffer most from infrastructure failure (the flow of raw sewage in high-density residential areas has been reported) and service delivery.
- The functionality of the ecosystem has been compromised by ongoing sewage pollution due to the collapse of infrastructure; for example, the water from the Vaal Barrage is no longer suitable for human or animal consumption.
- The SES components are not equitably considered, and this is linked to lack of technical capacity. The collapse of infrastructure has impeded the realisation of social and ecological distributive justice.
- Transparency is lacking in the decision-making and management processes, hindering citizens' influence in the decision-making process. This raises the issue of procedural equity; the participation of citizens in water resources is recognised as a human right.
- Infrastructure development has been negatively impacted due to tenders given to people who are not capable of delivering good standard services, and the poor-quality infrastructure has impaired the distribution of drinking water and sanitation. High-density residential areas are the most affected by infrastructure failure and service delivery.
- Top managerial posts are occupied by political people (comrades) who do not have the necessary skills, hence impeding the sustainable management of the ecological system.
- Components of the SES are not balanced, and the ecological aspect does not receive attention in decision making; politicians' decisions are focused on pleasing the public by building housing and ignoring water and sanitation infrastructure development. Appointees are in positions for a short period and hence are not held accountable for the problems they did not attend to.

5.4 Discussion

The aim of the study was to identify water governance challenges and their ethical dimension(s) with reference to the case study of the lower section of the Upper Vaal River Catchment. Identifying the primary challenges in the water sector was the first step in resolving and improving water governance (Romano & Akhmouch, 2019). Using the qualitative research approach, the study identified and analysed the water governance challenges and reflected on their ethical implications. The water governance challenges identified were i) failure to implement water legislation and regulations, ii) ineffective leadership and management, iii) cooperative governance and poor accountability, iv) decentralisation and ineffective participation, and v) finances, infrastructure and technical capacity.

The analysed data from the current study revealed that several water governance challenges flow from the failure of leadership in the water sector. Leadership plays a central role in facilitating the implementation of sustainable management practices in the water sector (Bhaduri *et al*., 2013). Poor leadership in the Department of Water and Sanitation has resulted in ripple effects, impacting the implementation of good water governance practice in the catchment. For example, the management and allocation of financial resources in the water sector has been raised as a serious challenge, whereby the Municipal Infrastructure Grant (MIG) is reallocated and channelled to other aspects that are not related to infrastructure. The collapse of municipal infrastructure is a major challenge in the catchment and has resulted in raw sewage flowing straight into rivers, together with discharges of non-compliant effluent (DWS, 2022; SAHRC, 2021; Tempelhoff et al., 2019). This situation threatens the present and future generations of water users within the catchment. In their study, Liu *et al.* (2011) argue that water scarcity is likely to increase because of the continuous neglect of wastewater management and infrastructure development.

Financial resources not only impact the refurbishment and maintenance of infrastructure, but also impact other aspects of governance and performance in the water sector (Berg, 2016; Ünver, 2008). All government sectors that are involved in water resource governance must be properly financially resourced. These sectors include research, planning and policy making, pollution control, monitoring regulations and compliance, and stakeholder engagement, among others (Akhmouch & Correia, 2016; Ünver, 2008). Therefore, mismanagement of financial resources can impact the functionality of all government systems (administrative, political, social, and economic systems). The mismanagement of financial resources in national and

government departments is mainly linked to political interference where ministers and local councillors push for projects that attract citizens' attention, for example, building houses and roads. There has been continuous neglect of infrastructure maintenance and development for over two decades.

The collapse of infrastructure raises ethical implications as it poses risks to both the society and the ecological system. The risk of collapse of infrastructure is externalised to the impoverished communities; it has been reported that raw sewage flows in the homes around Vanderbijlpark owing to blocked main sewers (SAHRC, 2021). Sewage pollution poses a serious health risk for humans as well as for ecological health and functionality. Fish kill has been reported in the CMF minutes that were analysed for this study (Leeu-Taaiboschspruit CMF, May 2007).

Systemic-relation (SR) ethics is one of the advanced approaches in the field of environmental ethics for addressing implications caused by pollution. Systemic-relation ethics advocates for equitable treatment of all components of the SES in decision and policy making (Odume & de Wet, 2019). This entails that in water governance processes, the interconnected relationship of the components of the SES should be recognised and treated as an integral system (the components are inseparable). The SR approach towards management and governance of water resources contributes to a sustainable and ongoing relationship between the social and ecological components.

Delays in the implementation of decentralised water institutions have been raised as another challenge to sustainable management of water resources in South Africa. For example, only two of the nine CMAs have been established and are functioning since the enactment of the NWA of 1998. The CMAs were initially reduced from nineteen to nine due to the challenge of implementation (Madigele *et al*., 2010; Weston & Goga, 2016). Decentralisation of water management to regional and catchment level has been recognised as an effective way of addressing local problems which are associated with wastewater and access to water (Cook & Bakker, 2012) because decentralisation fosters stakeholders' participation which is recognised as being effective in addressing local challenges. Local people are more competent when it comes to dealing with their own problems than people those from other levels of governance (Gupta & Pahl-Wostl, 2013). The delay in establishing the CMA in the Upper Vaal Catchment has impacted on stakeholders' engagement and participation in decision-making. Stakeholder engagement is one of the OECD principles, (Taylor *et al*., 2019) and has been identified as an

inevitable denominator in the development project, natural resource management and other local governance (Shunglu *et al*., 2022).

The catchment is recognised as the economic heart of South Africa, in the sense that it harbours several economic activities and contributes about 30% of the country's GDP (DWAF, 2004; Nieuwoudt *et al*., 2004). The instances of pollution caused by economic activities have negatively impacted other water users who have legitimate rights to the water resources; for example, tourism and recreational activities have significantly decreased (SAHRC, 2021). The ongoing raw sewage and industrial pollution is in contrast with the notion of 'a human right to clean and safe water' and 'a safe environment that is not harmful to their health' (McGregor, 2014). The risk of pollution is disproportionately distributed, the high-density residences are the ones that are mostly affected with raw sewage pollution; according to the data analysed, the collapse of infrastructure in areas like Sebokeng and Vanderbijlpark has caused raw sewage pollution to flow through residents' homes (SAHRC, 2021; Tempelhoff *et al*., 2019). The study by Banzhaf *et al*. (2019) on environmental justice showed that poor people and people of colour are disproportionately exposed to pollution.

5.5 Conclusion

Identifying water governance challenges and ethical dimensions is a step forward towards improving the management and governance of water resources in the catchment. Pollution and deterioration of water quality was identified as a major challenge in the catchment and has been recognised as caused by poor water governance practices. The top water governance challenges that were identified are: i) failure in the implementation of water legislation and regulations, ii) ineffective leadership and management, iii) cooperative governance and poor accountability, iv) decentralisation and ineffective participation, and v) finance, infrastructure and technical capacity. The water governance challenges raise serious ethical concerns about meeting human needs and ecosystem health. Ineffective implementation of the regulatory measures has contributed to recurring pollution in the catchment which has impacted both the ecological health and the people who rely on the river for drinking water, fishing, spiritual purposes, and tourism. Overall, the study contributes to the body of knowledge on water governance and deepens our understanding of the water governance challenges in the catchment as well as their ethical dimensions.

Chapter 6: Analysing equity dimensions among key institutional water users within the lower section of the Upper Vaal River Catchment.

6.1 Introduction

Equity is increasingly gaining attention in the water sector as an important value for realising sustainable water resource management (Özerol *et al*., 2018). In the studies of water governance, equity has been associated with good governance, human rights, social justice, and is recognised as a key value in achieving both intra- and inter-generational sustainable water resources (Carolini & Raman, 2020; Haie, 2021; Jiménez *et al*., 2020; Tortajada, 2010; J. Xu *et al*., 2019). In South Africa, equity is at the heart of post-apartheid water reforms aimed at addressing the past racial inequalities in water access and the benefits accruing from water resources (Rawlins, 2019).

Equity is one of South Africa's fundamental values of good water governance practice in the country and has been enshrined in the NWA of 1998 as one of three key principles (RSA, 1998). These key principles (equity, sustainability, and efficiency) constitute the pillars of water governance; they order and structure the way water resources are managed, protected, and governed at different scales in South Africa (RSA, 1998). Equity is clearly prioritized in recent policy developments, such as the 2013 National Water Resource Strategy and national Water Policy Review (Rawlins, 2019). The current study explores distributive and procedural equity dimensions in the lower section of the Upper Vaal River Catchment.

Equity was described in the Guide to the NWA 1998 of South Africa as providing equal access to water and its benefits, and fairness in the participation of everyone in decision-making processes regarding water resources. This definition of equity in the NWA 1998 narrows equity to focus on distributive and procedural equity. Distributive equity advocates for fair distribution of costs and benefits accruing from water resources, whilst procedural equity advocates for stakeholders' involvement and participation in processes of decision making and fairness in representation among affected and interested stakeholders, irrespective of their backgrounds (Grillos *et al*., 2021; Osman & Faust, 2021). According to Erdiaw-Kwasie *et al*. (2020), citizen participation in decision-making on water-related initiatives offers a valuable pathway to move towards more equitable and sustainable water delivery, now and in the future.

Distributive equity is crucial in South Africa's water sector and water governance in achieving sustainable water resources, as it advocates for fair allocation and use of water resources amongst different users. The lower section of the Upper Vaal River Catchment where this study focused, is a highly urbanized area where a variety of social and economic activities (mining, industries, wastewater discharge, agriculture, and a coal-fired power station) take place. These activities cause pollution that has resulted in the deterioration of the water quality of the Vaal River and the associated tributaries, affecting other water users who are not responsible for the pollution (DWAF, 2004). Therefore, exploring distributive equity among these key water institutions or bulk water users is crucial in addressing and ensuring fair water use in the catchment.

Several regulatory mechanisms exist to control water use and protect water resources in South Africa, including water-user licences (WUL), the polluter pay principle, wastewater discharge systems, the Green Drop programme. These regulatory mechanisms are categorised as source direct control (SDC) instruments (Odume *et al*., 2018). Compulsory licensing is the primary legal and administrative mechanism through which initial water allocation is performed (Rawlins, 2019). This study analysed and reflected on the effectiveness of these SDC instruments in achieving sustainable and fair water use amongst key water institutions or bulk water user in the lower section of the Upper Vaal River Catchment.

Equity is critical in the management of water resources, given the historical background of South Africa during the apartheid regime where racial discrimination determined the access and distribution of basic service delivery, which included water resources. Equity serves to redress these inequalities, whereby water resources must be distributed fairly amongst water users, regardless of race or gender, and must level the playing field (remove barriers) for fair participation in decision-making (Rawlins, 2019). Equity has been recognised as one of the attributes of good water governance (Jiménez *et al*., 2020). The practice of good water governance has been recognised as a solution in addressing the issue of equity (Rogers *et al*., 2003).

It has been argued that unless the goal of equity is defined, it may be impossible to measure, monitor and track equity-related improvement or otherwise (McDermott *et al*., 2013). Equity may operate at different social scales, for example, individual, community, sub-national and global levels (Xu *et al*., 2019), and thus a focus on the scale and goals of equity may help to identify and define the necessary parameters of equity. The scale of the equity analysis in this

study is the catchment, and the goal is egalitarianism whereby costs and benefits are seen to be distributed fairly and equally among the institutional water users. A secondary goal is needs-based, in which the analysis focuses on whether pre-existing contextual and social conditions are considered in supporting historically disadvantaged groups to participate in the decision-making processes. The objective of this chapter is to analyse equity dimensions among key institutional water users within the lower section of the Upper Vaal River Catchment.

6.2 Materials and methods

Key institutional water users within the lower section of the Upper Vaal River Catchment

The study focused on the key institutional and bulk/large-scale water users as candidates of equity. A focus on the key institutional and bulk water users is critical owing to their operational impact on the river's ecological sustainability and distributive equity. This is particularly true when one considers that activities of some of the water users, such as discharges from the municipal wastewater treatment works (WWTWs), impact the quality of the raw water abstracted for treatment and distribution, such as drinking water by Rand Water (bulk water supplier). Although there are various regulatory instruments, such as the application of the water quality licence/discharge permit, polluter-pay principle, water user licences (WULs), and the Green Drop programme aimed at controlling activities of water users within the catchment, their implementation remains largely ineffective (Ntombela *et al*., 2016; Tempelhoff *et al*., 2007), raising questions on equity. This section presents a brief description of the key institutional water users, as well as their activities and the potential costs externalised to other parties (**Table 6.1).**

Rand Water: is the largest private entity that is responsible for bulk water supply in the lower section of the Upper Vaal River Catchment and surrounding catchments. It abstracts water from the Vaal Dam and supplies a total of 13 local municipalities, 926 industries and 40 mines (Rand Water Annual Report, 2022). The volume of water abstraction ranges on average from 4 443 to 5 069 Mℓ/d (Rand Water Annual Report, 2022).

Local municipalities: The Upper Vaal River Catchment comprises the Emfuleni Local Municipality, Metsimaholo Local Municipality and Sedibeng District Municipality. The local municipalities supply potable water to the communities and provide wastewater treatment

services. More than 30 WWTWs are functional in the catchment and their impact has been to contribute to the water quality deterioration of the receiving water resources.

East Rand Water Care Company (ERWAT): is a private company responsible for wastewater-related services, including conveying, treating, and disposing of treated wastewater and sludges. Its activities are of critical importance owing to their likely effects on the receiving river resources.

Mining industries: Mining activities in the catchment include gold, coal, platinum, and uranium mining (DWAF, 2002). Gold mining is commonly situated within the lower section of the Upper Vaal River Catchment; mining companies include Gold Plat, Wits Gold, Harmony Gold, and Central Rand Gold. Mining activities (open-cast and underground) have severe impacts on the water resources through runoff and seepage. Old mines are mainly responsible for AMD pollution, which is a major challenge caused by the coal and gold mines in the catchment.

Agricultural water users: The main agricultural activities that impact the water resources are those of abstraction of water for irrigation purposes, and cultivation, which lead to diffuse pollution of nutrients and pesticides. The Vaal River supports smallholding farmers (subsistence farming) and the Vaalharts irrigation scheme, which is the largest irrigation scheme in South Africa. When the regulatory measures are not adequately enforced, abstraction of water from the river system alters the flow and affects downstream users.

Industrial water users: Industrial activities include petrochemical industries, mineral processing plants, fertiliser manufacturing, pulp and paper, steel industries and light industries (DWAF, 2004). Sasol and Eskom are the largest industries in the catchment, with Sasol producing 40% of the country's fuel, and Eskom producing almost all the electricity in South Africa (SAPA, 2023). The potential cost that Sasol externalises is that of pollution from its operations, and Eskom, which uses about 330 million m^3/annum of water for cooling purposes and keeping their power station running, alters streamflow.

Table 6.1. Different water users and the cost externalised.

Water institution	Main activities	Potential externalised costs	Examples of regulatory instrument applied to control activities
Rand Water	Abstracting	Altering stream flow	Water user licence
Local governments	Discharging	Poor effluent discharge and raw sewage pollution	Water user licence, Water quality licence, discharge permit, Green Drop programme
East Rand Water Care Company	Discharging	Poor effluent discharge	Water user licence, water quality licence, discharge permit, Green Drop programme
Mining industries	Discharging	Diffuse pollution – AMD pollution	Water user licence, water quality licence, polluter-pay principle
Agricultural water users	Abstracting	Altering stream flow and diffuse pollution	Water user licence
Eskom	Bulk water use, discharging	Pollution, and water quality deterioration	Water user licence
Sasol	Bulk water use, and discharging	Pollution and water quality deteriorating	Water user licence, polluter-pay principle
Other industrial water users	Discharging	Pollution and water quality deterioration	Water user licence, water quality licence, polluter-pay principle

6.2.1 Sampling strategy

Purposive sampling was used to select the participants for the study; stakeholders were identified and selected according to their experience and knowledge of the water governance processes of the catchment. These participants represented different institutional water users in the Vaal Barrage Catchment. The snowballing sampling approach was used, whereby participants from the interviews recommended and referred other stakeholders who are knowledgeable on the subject under study.

6.2.2 Data collection

The methods used for data collection are fully described in **Chapter 3**, **Section 3.4.** The study used a combination of different methods of data collection to gain an understanding of both the breadth and depth of water governance and water equity in the catchment. These methods involved both secondary and primary data sources. The secondary data sources involved document analysis, and primary data involved focus group discussions, key informant interviews and participant observation.

Document analysis

Documents that were reviewed and analysed includes CMFs minutes, reports (from government, media), and published research papers; these are given in **Appendix 1a-d** Document analysis was used to gain historical background and breadth of issues impacting on equitable management of water resources in the catchment.

Focus group discussions

Focus group discussions were constituted from the workshop which was held on 21 August 2019. Stakeholders knowledgeable about the water governance of the catchment were invited to participate; these included government representatives, representatives of industry, water quality experts and representatives from non-government organisations. The ten participants who attended the workshop were divided into two groups of five each. These discussions were conducted to gain an in-depth understanding of key issues that impact the benefits derived from the Vaal River. Care was taken in dividing the participants to ensure group diversity in terms of organisation, background, and interests.

Key informant interviews

Semi-structured questions (**Appendix 3**) were used to guide the participants on the subject whilst allowing them to freely express their knowledge and experience. A total of 10 interviews were conducted via the Zoom platform and were recorded on the laptop with the consent of the participants. The number of interviews (sample size) was determined using '*information power'* (Malterud *et al*., 2015). The information that was gained from each interview was relevant to the study owing to the vast knowledge and experience of the participants, which helped in determining the number of interviews conducted.

Participant observation

By taking a role as a participant observer, the researcher was able to validate the issues raised by other methods of data collection. This was achieved by attending CMF meetings of the Vaal Barrage and participating in one catchment monitoring survey conducted by Rand Water. The observation was guided by a template consisting of predefined questions of concerns that were raised through stakeholder engagement. Field notes were taken and photographs were taken where necessary.

6.2.3 Data analysis

Thematic analysis

Thematic analysis was used to analyse data from the qualitative methods of data collection, following the six steps developed by Braun and Clarke (2006). The six steps are fully described in **Chapter 3**, **Section 3.5.** The findings were presented in themes of recurring issues that have negatively impacted on the realisation of distributive equity.

Descriptive statistics

Descriptive statistics were used to analyse minutes from three CMFs (Klip, Leeu-Taaiboschspruit and Blesbokspruit forums) hosted in the 'Reservoir' website https://www.reservoir.co.za/viewforum.php?f=10. The descriptive statistics include the frequency and percentages of reported concerns that have negatively impacted on the realisation of distributive equity against key institutional water users. These reported concerns cover a period of nineteen years (2002–2021).

6.3 Results

This section presents the findings from the data analysis of concerns that impact the realisation of distributive and procedural equity in the lower section of the Upper Vaal River Catchment.

6.3.1 Analysing distributive equity among key institutional water resource users in the lower section of the Upper Vaal River Catchment

6.3.1.1 Key institutional/bulk water users and activities that may impact on distributive equity.

The activities of the main institutional water users within the catchment may affect access to the benefit of water resources by other users. To distil the concerns that have arisen from water uses by key institutional water users within the catchment, which may have implications for distributive equity, the minutes of the three catchment management forums within the study area (Blesbokspruit, Klip and Leeu-Taaiboschspruit) were analysed. The minutes span a period of 19 years from 2002 to 2021 (see **Appendix 1a**). The concerns raised include pollution by raw sewage, release of poorly treated effluent, and illegal discharges from illegal mining operations (**Table 6.2**). The key concerns raised regarding municipalities are those related to i) raw sewage which seriously impacts instream water quality, ii) discharge of poorly treated municipal wastewater and iii) poor infrastructure maintenance, leading to failure of infrastructure (particularly wastewater infrastructure). The minutes of the CMF meetings seem to attribute these concerns to systemic governance failure, which has led to infrastructure collapse and hence impact on the river ecology, and access to benefits of water resources by other water users in the catchment.

The catchment supports a variety of industries, including Sasol, Eskom, Arcelomittal, among others. These industries use water for a variety of purposes, including cooling, and effluent discharge. An analysis of the minutes of the CMFs suggests that the main concerns raised regarding industries relate to illegal discharges, poor quality of effluent sent to municipal wastewater treatment works, and spillages (**Table 6.2**). These concerns impact river water quality, with implications for biodiversity and social-economic development.

Table 6.2. Concerns reported against institutional water users in the Vaal Barrage CMFs as reflected in the minutes of catchment forums.

Institutional water user	Concerns reported against institutional water user
Municipalities/WWTW	▪ Raw sewage pollution, poor quality of effluent discharge, failure of infrastructure.
Industries	▪ Poor quality of effluent discharges, illegal discharges, spillage pollution.
Mining	▪ Illegal discharges from illegal mining activities, poor quality effluent discharge, AMD pollution
Agriculture	▪ Mainly illegal abstraction of irrigation water. The impacts of agricultural activities are mainly those reported as diffuse pollution.
Others	▪ Issues, like diffuse pollution, reported from unverified sources.

Concerns pertaining to mining activities reported in the CMFs include acid mine drainage (AMD), illegal mining practices, illegal connection of effluent discharge to the municipal pipes, and mine water management. Significant agricultural activities, which abstract water for irrigation, also take place in the catchment. The river supports subsistence farming and the Vaalharts irrigation scheme (the largest irrigation scheme in South Africa). The concerns that were raised in the CMF minutes against agriculture were those of illegal abstraction. Several other concerns which impact the water quality of the river, were reported from unverified sources, mainly issues of diffuse pollution.

The concerns raised against the key institutional/bulk water users have been identified to negatively impact the realisation of distributive equity. These concerns are presented in **Figure 6.1**, in descriptive statistics which clearly indicate the numerical values of the issues reported in the CMFs.

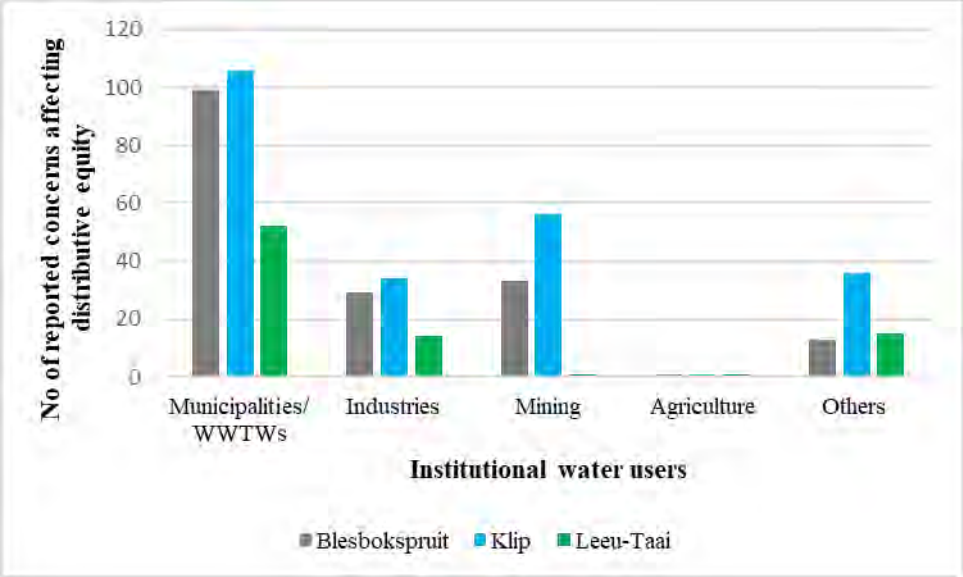

Figure 6.1. Reported concerns against key institutional water users in the Blesbokspruit, Leeu-Taaiboschspruit and Klip CMFs from 2002–2021 (Source: http://www.reservoir.co.za/).

Over the period of the 19 years, several concerns against some of the key institutional water users were raised repeatedly. The highest number of concerns raised by participants in the CMF meetings appear to target municipalities, followed by mining and industries. For example, over the 19-year period analysed, municipalities across the catchment received 257 concerns, amounting to 52% of total concerns raised by CMF participants (**Figure 6.2**). Surprisingly, agriculture, despite being significant in the catchment, received the least number of concerns (three, amounting to 1%). The results suggest that municipalities, the mining sector, and industries are critical to realising equity among key water users within the catchment. Their activities impact negatively on and externalise costs to other users who have legitimate rights to the benefits of water resources in the catchment.

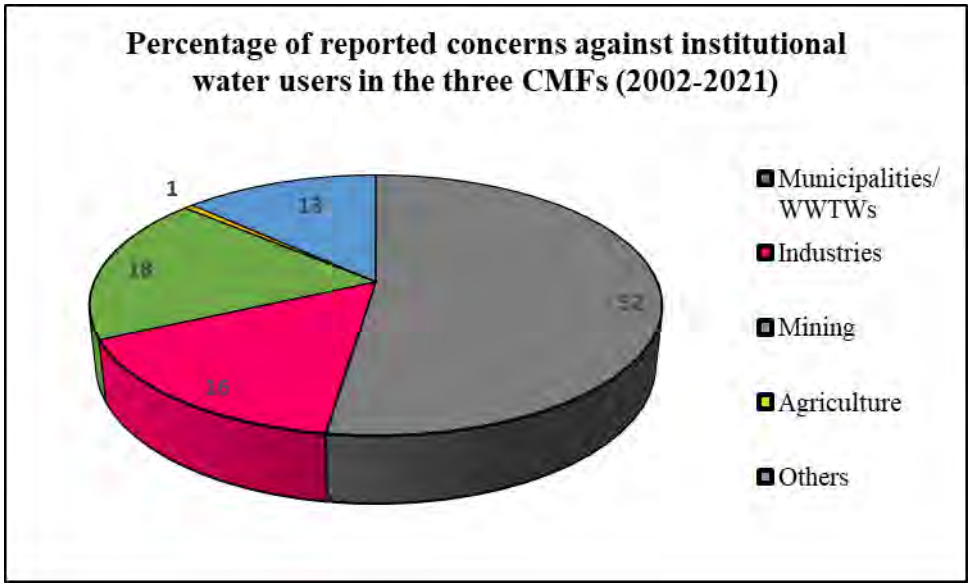

Figure 6.2. Percentage of the total concerns reported against key institutional water users from the three CMFs from 2002–2021 (Source: http://www.reservoir.co.za/).

Distributive equity in water resources advocates for the fair distribution of benefits and costs among water users. The activities carried out by key institutional water users in the catchment have significantly impacted other water users; for example, the tourism industries have been significantly affected by the pollution, and recreational activities have decreased (SAHRC, 2021). The cost of pollution caused by mining activities, industries and municipal WWTWs is externalised to other water users who are not responsible for it.

6.3.1.2 Key drivers of distributive equity concerns in the catchment

Identifying key drivers of distributive equity concerns is critical in ensuring that the water governance processes are designed in a way that stakeholders and actors reliant on water resources within the catchment have equitable and fair access without the effects of externalised costs from other actors. The analysis of the data indicates that three key drivers of distributive equity concerns are critical in this regard. These key drivers are i) pollution and water quality deterioration, ii) the legacies of mining activities, and iii) poor infrastructure maintenance, vandalism, and theft.

Pollution and water quality deterioration

Pollution is a major challenge in the lower section of the Upper Vaal River Catchment, and it has severely impacted the water quality of the Vaal River. *The Vaal Report* by the South African Human Rights Commission of 2021, indicated that the Vaal River is polluted beyond

acceptable standards. The deterioration of water quality has resulted in the reduction of the ecosystem services supplied by the river. For example, water from the Vaal Barrage Dam is no longer fit for human or animal consumption and thus Rand Water, which is one of the key institutional water users (bulk water supplier), stopped abstracting water from the Vaal Barrage Dam. Pollution in the catchment is seen as been endemic and age-long. This is reflected in the view of one of the interviewees as follows:

> *That's been endemic, and it goes back to in the 1930s when it really started getting serious. There was a time when Rand Water extracted its water from the Vaal Barrage to purify at its Vereeniging works and then in the 1950s they started cutting out the Vaal Barrage Dam increasingly and they started moving towards extracting the water supply directly from the Vaal Dam* (Interview).

The water quality of the river has deteriorated over the past decades and now people no longer drink and use the raw water like before. One of the interviewees showed deep concern about how the water has significantly deteriorated beyond unacceptable standards. The interviewee said:

> *I started as a rafter on the Vaal River in about 1998, somewhere there, those days for instance when you get thirsty, you just take water and splash it in your mouth. But not anymore, it's just gone backwards to be honest it has gone backwards and backwards* (Interview).

The pollution happening in the lower section of the Upper Vaal River Catchment is mainly caused by recurring incidents of raw sewage flowing around the catchment and into the river, frequent discharge of partially treated effluent, mining activities, industries, urbanisation, and agricultural activities. The result has been the deterioration of the water quality which has negatively impacted the ecological health of the river system. As indicated in the earlier analysis of the minutes of the three CMFs, there is widespread perception that the municipalities within the catchment have contributed greatly to the deterioration of water quality. There is evidence of raw sewage and partially treated effluent impacting the water quality of the Vaal River and the associated tributaries, as reflected in the CMF minutes, and based on water quality monitoring exercises regulated and conducted by Rand Water and the Department of Water and Sanitation (DWS). The water quality monitoring conducted in the catchment reflects that the sampling points downstream of WWTWs indicate the impacts of

discharging non-compliant effluent in the river. The following quote is an example of reported water quality issues from the CFM minutes:

> *Unacceptable levels of ammonium, COD, E. coli and phosphate recorded during this quarter. This sampling point is downstream of Goudkoppies Wastewater Treatment Works and is being impacted by the discharge of untreated or partially treated sewage effluent from the Works* (Blesbokspruit CMF, August 2020).

A distributive equity perspective suggests that while the municipalities are the biggest polluters, the costs seem to be borne by other bulk water users, a perception shared by the participants from one of the focus group discussions as indicated below:

> *Who is the biggest polluter? Municipality. You think they are going to have money to fix their works. It's never going to happen. The people who are going to pay is Sasol and all other industries* (Focus group discussions).

The tourism industry within the catchment seems to be significantly affected by the pollution in the Vaal River and recreational activities have decreased. For example, during a catchment survey by the researcher on 9 October 2021, a manager at one of the most famous hotels located on the banks of the Vaal River indicated that sewage pollution was affecting their business. The manager stated that:

> *There was a time when our guests checked out because of the smell from the sewage that was coming from the river to the guests' rooms, and we had to refund them. Another time the sewage was running through our golf course into the river* (Catchment survey, 9 October 2021).

The on-going pollution also represents serious risks to human health. In a focus group discussion held on 21 August 2019, the issue of pollution affecting the health of people who go into the river was raised as a serious concern by participants. One of the participants stressed that:

> *I have a picture of a guy who went fishing on the river and walked into shallow water to carry his castle-line and he cut his toe on a sharp object, I will show you just before lunch. He almost lost his foot from infections. He lost half of his toe, just a little cut* (Focus group discussions).

Not only tourism and recreational activities are affected by the pollution and deterioration of water quality in the lower section of the Upper Vaal River Catchment. There are millions of people (approximately 19 million) who depend on the river for their wellbeing, deriving both direct and indirect benefits. The Vaal River is a source of living for many people, in terms of drinking water, food (fishing and agriculture), employment, and economic development of the country. The benefits derived by these different water users are negatively impacted by pollution and water quality deterioration. One of the participants from the key informant interviews voiced concern about the pollution affecting other people who depend solely on the river for their livelihoods:

> *It's not just us in the tourism industry, but there are people who depend on the river for food. I know some guys go fishing on the river for food and make a living out of it* (Interview).

Pollution is a major concern for key institutional water users as it has negative effects on the benefits that are derived from the river. Animal farming is seriously affected by water deterioration as some toxins from the polluted water are lethal to animals. Several issues have been reported in the CMF minutes; some of the concerns that were reported are highlighted below:

> *Highly contaminated (toxic) and contains phosphates of 1200 mg/l and nitrates of 1500 mg/l. Three head of cattle belonging to Sakkie de Villiers died after the cattle gained access to the Driefontein Dam and drank water from the dam.* (Leeu-Taaiboschspruit CMF, July 2004).

> *Karan Beef raised concern with faecal coliform as this affects cattle.* (Blesbokspruit CMF, November 2005).

The quality of water in the river is critical in the realisation of distributive equity. Given that other water users in the catchment rely on the raw water, pollution and the deterioration of water quality has significantly affected the benefits they derive from the river.

Legacies of the mining industries

The catchment harbours several mining activities, with a significant number of coal and gold mines. These mining activities have short- and long-term impacts on the environment and water resources (underground and surface water). The analysis of this study indicated that mining

activities (old mine dumps and actives mines) contribute significantly to the deterioration of water quality of the Vaal River and the associated tributaries.

Coal mining is mainly underground, with some open-cast mines. The impact of coal mining on water resources in both cases is an increase in sulphates, acidity, and total dissolved solids (TDS). Gold mining has also greatly impacted the water quality of the Vaal River, mainly through AMD pollution which originates from the mine dumps around the catchment, flows into the rivers and seeps into the groundwater. The water quality monitoring data which are regularly presented in the various CMF meetings and documented in the minutes indicate AMD pollution contributed to water quality deterioration in the lower section of the Upper Vaal River system.

The mining challenge is a legacy one, inherited from the previous apartheid government. A key problem arising from this legacy problem is that of high levels over 2500mg/l. Although the current South African government seems to be addressing the problem, there is perception that the action being taken is not very effective:

> *Another problem is the abandoned mines which the government is taking responsibility, although not effectively* (Interview).

The effluent discharged to the WWTWs by mines is a challenge as it does not comply with the WUL parameters. Analysis of the data collected indicated that some mining companies operate before getting a WUL, as indicated below:

> *There are lots of issues with mining and water, they get mining rights before they get water license and it's a big issue* (Interview).

> *Burnstone Gold Mine – located near Balfour, they don't have discharging permit, they have been discharging for some time, they applied for WUL amendment which is still pending. Currently they are using stringed limits for instream water quality objectives to comply with. Their pH from return water dam is sometimes high and when they look at the downstream and instream shows non-compliance, not only to the WUL limits also to the calculated water quality limits* (Blesbokspruit CMF, February 2021).

Illegal mining activities are another source of toxins in the water system in the catchment. Several illegal mining activities, which make use of toxic chemicals like mercury, have been reported in the CMF minutes. The illegal miners dispose of untreated effluent in the river

system through illegal connections to the sewer systems, as shown in in one of the DWS water quality reports, which indicated that:

> *We also note the slight sewage contamination at the Nigel stormwater canal due to illegal mining activities* (Blesbokspruit CMF, August 2021).

Mining activities, whether legal or illegal, have contributed significantly to the deterioration of water quality of the rivers in the catchment, and negatively impacted the benefits derived from the Vaal River. The impacts of pollution caused by these mining activities are externalised to other water users in the catchment.

Poor infrastructure maintenance, vandalism and theft

Municipalities are responsible for basic service delivery, which includes the supply of safe water and sanitation to the community. However, poor maintenance of infrastructure has become an impediment to effective distribution of water resource to individuals. The collapse of sewerage infrastructure has negatively impacted the water quality of the river system due to spillage and the overflow of raw sewage in the catchment. The CMF minutes report several incidents of raw sewage pollution in the catchment which are the result of the collapse of infrastructure, like manhole blockages, burst pipes and malfunctioning pump station. These issues are reflected in one of the reports by Metsimaholo Local Municipality from the CMFs minutes:

> *76 blockages in Sasolburg; 47 burst pipes.* (Leeu-Taaiboschspruit CMF, August 2018).

Another report by the City of Ekurhuleni reflected the significant impact infrastructure failure has on the water quality:

> *Tsakane upstream the quality is extremely poor due to overflowing pump station and sewer blockages in the area, and all reported to City of Ekurhuleni.* (Blesbokspruit CMF, February 2021).

The malfunction of infrastructure has significantly affected the quality of the effluent discharged in the river. The Green Drop report of 2022 noted the decrease of the 'Green Drop score' of Metsimaholo Local Municipality from 69% in 2013 to 11% in 2022 (DWS, 2022), the main causes of which were those of infrastructure, as indicated below:

Sewer pump stations spillages and sewer network manholes in poor conditions (DWS, 2022).

The Green Drop score of Emfuleni Local Municipality decreased significantly from 81% in 2013 to 37% in 2022; three out five issues that were reported as needing attention were linked to infrastructure maintenance (DWS, 2022). These were reported as follows:

Electricity supply dysfunctional, mechanical upgrades required as most units have deteriorated due the non-functioning of the works, civil upgrades required – especially on the bio-filters, and mechanical, civil and electrical upgrades are required at all works (DWS, 2022).

Infrastructure problems have caused ongoing raw sewage pollution in the catchment. The photograph in **Figure 6.3.** was taken on 9 October 2021 during the catchment survey carried out by the researcher. The photograph shows raw sewage flowing directly into the river owing to the failure of Pumpstation 8 in Vereeniging.

Figure 6.3. Raw sewage flowing into the river, caused by failure of Pumpstation 8 in Vereeniging (taken by Noleen Tavengwa 09/10/2021).

The long-neglected infrastructure now requires billions of rand to fix and upgrade. Several pipes were installed in the 1950s and have not been properly maintained. The old pipes are collapsing, causing severe pollution in the catchment and rivers. One of the participants indicated that:

> *The thing is, they haven't been prioritising infrastructure for maybe about two to three decades. It's hard to catch up on two to three decades of neglect* (Interview).

Intentional vandalism of municipal infrastructure by the local community members has been recognised as a challenge in the catchment and contributes to the malfunctioning of infrastructure. Vandalism normally occurs during protests for service delivery and during theft incidents. These issues have been frequently reported in the CMFs, as the following quotes record:

> *Communities are breaking down municipal infrastructure in an attempt to get the attention of their councillors to attend to their grievances in terms of service delivery challenges* (Klip CMF, August 2021).

> *Received about 860 incidents call per months due to vandalism and failure of pump stations* (Klip CMF, May 2010).

Participants in the focus group discussion confirmed this issue of vandalism as a recurring problem and noted its effects on the functioning of the WWTP. One of the participants indicated:

> *And you find infrastructure is frequently destroyed, such as pumpstations, pipelines are damaged, and the consequence is that WWTP cannot function properly, and there is no way in which you can make what needs to be the national key point really safe against vandalism and theft of infrastructure equipment* (Focus group discussions).

The SAHRC report revealed that raw sewage pollution and non-compliant discharges of effluent from the WWTW of the Emfuleni Local Municipality were exacerbated by theft and vandalism of infrastructure by local community members. Theft and vandalism have caused serious damage to the infrastructure, resulting to the ineffectiveness of wastewater management. Theft of electric cables at the WWTW has been frequently reported in the CMFs, and this negatively impacts the final effluent discharged into the rivers. During the catchment survey, the researcher visited Leeuwkuil Wastewater Care in Emfuleni Municipality on the 9 October 2021. The treatment plant had not been working for over six months prior to the visit owing to cable theft, and untreated effluent was discharging straight into the river. Cable theft from the WWTWs has been raised as one of the major challenges impacting the functionality of treatment plants and contributing to non-compliance in terms of the quality of effluent

discharged in the rivers. The data analysis from CMF minutes has shown recurring reports of cable theft at WWTWs in the catchment:

> *Works are affected by power outages and cable theft which lead to operation interruptions* (Klip CMF, May 2021).

Infrastructure development and maintenance is crucial in equitable distribution of water resources. The analysis for this study showed that poor maintenance of sewerage infrastructure and recurring vandalism by the community have significantly impacted the water quality owing to sewage contamination in the river systems. Failure of WWTW infrastructure is a major challenge in the catchment and has impeded the realisation of distributive equity amongst water users in the lower section of the Upper Vaal River Catchment.

6.3.1.3 Towards distributive equity in the lower section of the Upper Vaal River Catchment- application of the source direct controls

Source Direct Control (SDC) instruments are used to control and regulate the activities of water resource users in order to ensure that water resources are protected and remain sustainable (Odume *et al*., 2018). Apart from ensuring that water resources are protected, the fair application of SDC instruments ensures that the diverse interests of various water resources users are considered and protected. For example, a commonly applied SDC instrument is water use licensing (WUL). Before a new water use licence is granted, the regulator often considers the impact of the planned activities on both the aquatic ecosystems and on existing users of water resources. In this way, SDC instruments are used to ensure that equity matters are considered in terms of access to water resources. However, the realisation of distributive equity through SDC instruments rests on their effective implementation, compliance monitoring and enforcement. Although it appears that some SDC instruments are being implemented, there is a perception that compliance and enforcement monitoring is poor. This is reflected in the analysis of the data as indicated by one of the interviewees:

> *The challenge is in enforcing the law, which is more on the corruption side. Who doesn't know that the Vaal is polluted? If the municipalities continue to say we have people who monitor but there are no results, that means the monitoring is not effective* (Interview).

Apart from the challenges of implementing the various SDC instruments, several illegal water-use activities in the catchment have negative implications for distributive equity. This seems

to arise out of administrative delays in issuing water use licences. The main contention is that the application process takes too long, which then seems to encourage illegal water use, as reflected in the forum minutes below:

> *Some WWTWs in the catchment did not have WULs* (Leeu-Taaiboschspruit CMF, November 2017).

> *Burnstone Gold Mine – located near Balfour – they don't have a discharging permit; they have been discharging for some time, and they applied for WUL amendment which is still pending* (Blesbokspruit CMF, February 2021).

Issues of illegal abstraction of water from the river have also been reported in the CMFs. Several farmers abstract water from the river for irrigation purposes without a WUL. An estimated 174 million m^3/annum of water is unlawfully abstracted for irrigation purposes in the entire Upper Vaal region (Ginster *et al*., 2010). The unlawful abstraction of water has been recognised as contributing to the imbalance of the water supply scheme of the Vaal River. The distributive equity of water resources amongst institutional water users is negatively impacted due to the unaccounted abstraction of water by farmers in the catchment. The water users are obliged to attend CMFs in which the presentation of water quality or pollution incidents are made.

Pollution from the WWTWs has been recognised as a major challenge in South Africa, as evidence in the Vaal Barrage Catchment shows. Incentive-based regulation (Green Drop) was introduced in 2008 to motivate the WWTWs to comply with the quality of effluent discharged into river systems (Ntombela *et al*., 2016). The Green Drop process involves an assessment of every stage of the WWTW, starting from receiving wastewater from different dischargers to the treatment and to the discharge of the effluent into the river. The WWTW is given a score from 0-100%; those wastewater works which fail to achieve the minimum Green Drop target of 31%, will be placed under regulatory focus. This regulation serves as a motivation for WWTW to comply with the treatment of the wastewater by awarding the best performing works with scores of 90% and above. The non-complying WWTW are charged penalties , and awareness is raised on the issues that prevent the works from complying. However, the effectiveness of the Green Drop is not significant; the percentage of municipal wastewater systems that were identified as in a critical state in 2022 has increased to 39% as compared to 2013 which recorded 29% (DWS, 2022).

The implementation of compliance and enforcement measures has proved to be a challenge not only in the lower section of the Upper Vaal River Catchment, but in South Africa as a whole. Capacity constraints from the national government (DWS) have been recognised as an impediment to effective legal enforcement, for example, only about 79 inspectors deal with prospecting and mining applications as well as infringements for the whole country. This limitation slows down the approval process of WULs, and mining companies end up operating without approved WULs.

6.3.2 Analysing procedural equity in the lower section of the Upper Vaal River Catchment

Procedural equity is the second dimension of equity elaborated in the NWA of 1998 definition for equity. Procedural equity was defined as fair participation of individuals and social groups in decision-making processes affecting water resources. The NWA of 1988 advocates for decentralisation and democratisation of institutions and processes of decision-making of water resource management. A total number of 19 catchment management agencies (CMAs) were to be established, and CMFs were used as platforms to allow public participation in the establishment of CMAs. The CMFs play the role of a consultative-advisory to the DWS in the establishment of CMAs, and a consultative and advising role to municipalities in connection with the Integrated Development Plan (IDP).

According to the DWS, the role CMFs are to act as a communication channel between catchment residents and local government, municipality and other institutions in managing water resources at catchment level (Burt *et al*., 2016). In this study, CMFs are taken as a vehicle for realising procedural equity as they bring together all water users in the catchment. The stakeholders who participate in the CMFs (Blesbokspruit, Leeu-Taaiboschspruit and Klip) analysed for this study include national and local government, industries, mining companies, the power generation company, community, farmers, tourism businesses, researchers, public servants, and representatives of NGOs. The national government can engage directly with all the stakeholders involved in the catchment, as was highlighted by one of the interviewees from the national government department:

> *The aim of these meetings is to engage directly with the stakeholders of the catchment forum, we discuss all things that can actually impact on the resource* (Interview).

Stakeholder participation is crucial for the effectiveness of CMFs. However, participation of local government (municipalities) has been a challenge and some of the stakeholders do not participate regularly, as shown in the minutes that were analysed for Blesbokspruit, Klip and Leeu-Taaiboschspruit CMFs. The failure of the municipalities participating in the CMF has negatively impacted the effectiveness of these meetings as other stakeholders are unable to engage directly with municipalities concerning issues that directly link to municipalities. One of the participants from the focus group discussions complained about the municipalities:

> *But there is big failure from the government side, because first of all, I have my quarterly meetings with the stakeholders, and without fail, the representative from Metsimaholo or the local municipality never pitches up, so we can't even talk with them about the issue. We complain amongst ourselves, we have minutes of meetings and its up on the reservoir website for everyone to read* (Focus group discussions).

The CMFs are supposed to empower and give voice to the marginalised, by creating a safe space in a small gathering where people meet to discuss water issues. However, some stakeholders, like civil society, are not well represented in these CMFs. This was raised as a concern by the participants that civil society (residents) does not actively participate in the forums, and the government representatives who do participate do not have power to take informed decisions in the forums. As a result, the forums are ineffective in achieving their purpose and goal; mostly issues are raised, but no significant action takes place. Some of the participants from the interviews elaborated on this matter:

> *I feel that there are other stakeholders that need to be playing a role, where they are actually failing* (Interview).

> *Communities are not well represented, they don't even know that when you do this illegal dumping, you are actually impacting on the resource; they just see a river just passing next to them and they throw whatever they throw in* (Interview).

> *In other words, forums just end up in talk shows, because there in no one significant or no one from the DWS who has been designated to attend the meeting that can actually make decisions of the meeting* (Interview).

Another issue that was raised by participants was that stakeholders participate in the forums for different reasons. Most of the stakeholders participate in the CMFs as a requirement of

WULs, which means there is no interest whatsoever in the sustainable management of water resources. Some participants indicated that:

> *The CMF, the ones that I attend to in the Vaal Dam Catchment, those people only attend there because of licence requirement; licence requires them to be there* (Interview).

> *There is no group of people to actually take on water resource management because everybody is there for different reasons, and it seems that the CMFs are used just as a platform to provide information and then move on* (Interview).

Participants are not satisfied with the effectiveness of the CMF is water resource management and some areas of attention were suggested to make the CMFs more effective. One the participants said:

> *There are two things, either give CMFs legal status, in other words, they need to be a fully legal entity that can take on issues and have necessary capacity behind them to resolve issues, or the DWS must ensure that the correct people who can take decisions that are raised by stakeholders, that they actually attend the forum meetings and can give answers and decisions and guarantee of the meetings* (Interview).

6.4 Discussion

The aim of this chapter was to analyse the two dimensions of equity – distributive and procedural equity – with reference to the lower section of the Upper Vaal River Catchment. The challenge of water distribution and allocation represents a fundamental component of water governance due to the inherent trade-off between different actors and stakeholders (Rawlins, 2019). Equity is one of the attributes of good water governance (Biswas & Tortajada, 2010; Jiménez *et al*., 2020), and an effective water governance system has to ensure equitable distribution of costs and benefits of water resources amongst water users. However, equitable governing of water resources is complex, given the diversity of values derived from water, so making it more difficult to have a universal assessment of equity (Miranda *et al*., 2011).

Pollution and water quality deterioration have been raised as a major challenge in the catchment and have negatively impacted on the realisation of distributive equity amongst different water users. The activities carried out by key institutional water users (municipalities, mines, industries, and agriculture) have significantly contributed to the deterioration of water quality in the catchment. Insufficient and poor management of wastewater treatment has been

identified as one of major causes of water pollution in South Africa (Ntombela *et al*., 2016). The failure of infrastructure of municipal WWTWs dominated the analysis of CMF minutes and has been reported as a recurring contributor to water quality deterioration in the catchment. The study by Liu *et al*. (2011) predicts that the future water crisis will be sparked by continuous neglect of wastewater management and not necessarily because of physical scarcity.

The cost of pollution has been externalised to other water users who are not necessarily responsible for the pollution. For example, the challenge of raw sewage pollution caused by municipalities has significantly contributed to a decrease of tourism and recreational activities in the catchment (SAHRC, 2021). Farmers are equally affected by pollution as the contaminated water affects livestock. In one of the CMFs, it was reported that three head of cattle died after drinking water from the Driefontein Dam. Pollution results in the disappearance of ecosystem services and affects the social and ecological systems (Wellington, 2021). Continuous input of contaminants in river systems can ultimately exceed the resilience of an ecosystem, resulting in dramatic and irreversible losses (Cosgrove & Loucks, 2015).

The study by Osman and Faust (2021) proves that the availability of water does not guarantee fair distribution and access to safe water for everyone. Distributive equity of water resources relies on the effective implementation of the water legislation and water user control instruments (Jeffrey, 2018). Ineffective and partial implementation of the SDC instruments has been identified as a challenge that has impeded the fair distribution of benefits and costs among water users in the catchment. Several incidents of illegal abstraction of water for irrigation purposes have been reported in the CMFs; this is the result of delays in the application process for WULs. Illegal abstraction of water is identified as a source of overexploitation and overuse of water resources (Ginster *et al*., 2010). The delay in WUL applications has also resulted in some mining and industries operating without WULs, and the implications are that their activities are poorly regulated and may affect other water users who are then left to carry the cost.

An important step toward more equitable and sustainable water distribution is to involve citizens in decision-making about water-related initiatives (Erdiaw-Kwasie *et al*., 2020). The South African water legislation (NWA of 1998) advocates for inclusiveness and participation of citizens through decentralisation of water resources at catchment level. The current study identified CMFs as the vehicle for procedural equity because they bring together all water users, stakeholders and government representatives to discuss water-related issues in the

catchment. However, analysis revealed the ineffectiveness of these CMFs in the participation of stakeholders and water users. Participants lack commitment and there is no common interest, as several representatives from industries and mines attend the forum meetings because it is a requirement of the WUL. Citizens are not represented in the CMFs although their participation is identified as crucial in achieving equitable use and management of water resources. Citizens' participation creates an atmosphere of openness and transparency, reducing the risk of making decisions which contradict the interest of the public (Lee *et al.,* 2022; Shunglu *et al*., 2022).

Inclusiveness and participatory approaches in water governance have been identified as crucial in addressing pollution from both point and diffuse sources, and in the fair distribution of benefits and water use at a catchment level (Benson *et al*., 2015). Participation and inclusiveness of stakeholders yields several benefits, which include efficient and responsive management, conflict management, informed decisions through a diverse range of perspectives, social enhancement and institutional capacity in handling complex water challenges (Margerum & Robinson, 2015). The current study reflected that the delay in decentralising water resources through the establishment of CMAs is a key factor that has hindered the CMFs from effectively contributing to participation of stakeholders and citizens.

6.5 Conclusion

The Vaal River supports a population of approximately 19 million people and provides both direct and indirect benefits (social and economic activities). The current study has shown that the activities carried out by the key institutional water users in the catchment impact the quality and quantity of water resources which are crucial factors on the realisation of distributive equity. For example, the pollution caused by industries, mines and municipalities has resulted in the deterioration of the water quality, the costs of which are externalised to other water users who rely on raw water, such as the farmers and Rand Water.

Exploring the key drivers of distributive equity concerns was critical for this study to ensure that the water governance processes are designed in such a way that stakeholders and actors reliant on water resources within the catchment have equitable and fair access without the effects of externalised costs from other actors. Participation of stakeholders and citizens is critical in addressing human-induced water problems and in achieving more equitable use and management of water resources.

The current study analysed distributive and procedural equity in the catchment to identify challenges pertaining to stakeholders' and citizens' participation in the management and distribution of water resources. Regarding distributive equity, the analysis of the current study revealed that activities of the key institutional water users within the catchment have impacts on the realisation of distributive equity due to ineffective implementation of the SDC instruments, enforcement compliance and monitoring. The effectiveness of the catchment management forums in the realisation of procedural equity is vague due to poor participation of stakeholders.

Chapter 7: Synthesis, Conclusion and Recommendations

7.1 Synthesis

The intention of this research was to bring to light the importance of values and ethics in water governance and management of water resources. The study adopted an ethical framework developed by Odume *et al*. (2022) for distilling the ethical implications of the identified water governance challenges in the lower section of the Upper Vaal River Catchment. The framework draws on insights from water justice literature (Doorn, 2013); water ethics (Brown & Schmidt, 2010); and environmental ethics (Odume & De Wet, 2019). The study also highlighted several perspectives of ethics in which values claims and claimants can be interpreted and clarified, with reference to the ethical framework developed by Odume *et al*. (2022). The ethical framework for analysing value claims and claimants, draws from consequentialism, deontology, virtue, systemic-relational ethics and African ethics, that is, *ubuntu* moral theory (Odume *et al*., 2022). The ethical approach and considerations in water use and management have been recognised as contributing to achieving long-term sustainable water resources (Amir *et al*., 2021; Shanono, 2021; Stefanovic & Adeel, 2021).

Chapter 5 addressed the first objective of this study, which was to analyse water governance challenges and ethical dimensions. Five primary water governance challenges were identified in the lower section of the Upper Vaal River Catchment, namely, i) failure in the implementation of water legislation and regulations, ii) ineffective leadership and management, iii) cooperative governance and poor accountability, iv) decentralisation and ineffective participation, and v) finance, infrastructure, and technical capacity. These water governance challenges have ethical implications in the realisation of sustainable management of water resources, which impact both social and ecosystem functionality.

Leadership was recognised as playing a central role in facilitating the implementation of sustainable management practices in the water sector (Bhaduri *et al*., 2013). The role of leadership is to drive the mandate to achieve equitable, sustainable, and efficient use, management and protection of water resources. When the leadership fails to drive this mandate, it negatively impacts the other institutions who rely upon their leadership. According to the data analysis, poor leadership has resulted in ripple effects that have negatively impacted the functionality and implementation of good water governance practice in the catchment. Poor leadership has yielded mismanagement of finances, lack of transparency and accountability, poor cooperative governance, implementation challenges of legislation and regulatory

measures, and corruption, among others. Inefficient implementation of the water user licences, and water quality licences or discharge permits has led to multiple incidents of discharge of poorly treated effluent, illegal discharges, and illegal abstraction of water from the river systems. The ethical implication raised here is that of responsible use of water resources and equitable treatment of the SES components. The inefficient implementation of the SDC instruments also raises the issue of distributive equity which is not fully realised as pollution caused by industries, mine, and municipality has negative impacts on other water users (mainly those who abstract raw water), such as the farmers and bulk water distributors.

Chapter 6 focused on distributive and procedural equity dimensions in scrutinizing water governance challenges in the lower section of the Upper Vaal River Catchment. This study examined the key institutional and bulk water users in addressing the challenge of pollution because their operations have significantly impacted the ecological and ecosystem services derived from the Vaal River. The key institutional water users are the industries, municipal WWTWs, mines and agriculture. The study revealed that the activities carried out by these key institutional water users have indeed negatively impacted the realisation of distributive equity. The major externalised effects are those of pollution, with the municipality and WWTWs having the highest number of concerns reported against them from the CMFs minutes that were analysed for this study. These concerns were those of raw sewage pollution, collapse of sewage infrastructure, and discharging partially treated effluent.

The effect of pollution is externalised to other water users who are not responsible for it. Tourism and recreational activities have decreased significantly owing to the pollution (SAHRC, 2021), and the polluted water is not fit for human or animal consumption, affecting Rand Water (bulk water distributor) and farmers who abstract raw water. The study indicated three key drivers of distributive equity concerns which are critical in this regard: i) pollution and water quality deterioration, ii) legacies of mining activities, and iii) poor infrastructure maintenance, vandalism and theft. It was critical to identify the key drivers of distributive equity concerns in addressing water governance challenges in the catchment. This was done to ensure that the water governance processes are designed in a way that stakeholders and actors reliant on water resources within the catchment have equitable and fair access without the effects of externalised costs from other actors.

The study exposed the ineffective and partial implementation of the SDC instruments to be an impediment in the fair distribution of benefits and costs among water users in the catchment.

Although there are various regulatory instruments, such as the application of the polluter-pay principle, water user licences (WULs), and the Green Drop Programme aimed at controlling activities of water users within the catchment, their implementation remains largely ineffective (Ntombela *et al*., 2016; Tempelhoff *et al*., 2007).

Inclusiveness and participatory approaches in water governance have been identified as crucial in addressing pollution from both point- and diffuse-sources and in the fair distribution of benefits and water use at a catchment level (Benson *et al*., 2015). Previous studies have regarded stakeholder participation as critical in addressing human-induced water problems like pollution, infrastructure development, illegal abstraction among others (Cook & Bakker, 2012; Erdiaw-kwasie *et al*., 2020; Lee *et al.,* 2022; Neef, 2009). In this study, CMFs were taken as a vehicle for realising procedural equity as they bring together all water users in the catchment. However, delay in establishing the Upper Vaal CMA has impacted on the functionality of the CMFs in participatory and inclusive water governance. Once established, CMFs are intended to play an advisory role to the CMA. The participants in the study referred to the CMFs as mere 'talk shows', a notion that reflects that nothing of significance comes out of the CMFs in decision-making or solving water governance challenges faced in the catchment. Participation of stakeholders is also poor in these CMFs; municipalities and citizens do not participate, and industries participate because the WUL mandates them to attend. One can conclude that participation is poor to nearly absent even though participation and inclusiveness have been identified as an effective way to achieve equitable and sustainable water distribution and use (Erdiaw-Kwasie *et al*., 2020).

7.2 Conclusion

The study highlighted the ethical approach and value of equity in addressing water governance challenges in the lower section of the Upper Vaal River Catchment. The identified water governance challenges all border on ethics as do the equity concerns that were raised in the study. An ethical approach in water governance is absent in the South African water sector. The current study brought to light how water governance challenges result in concerns of ethics and how an ethical approach can intervene in addressing these challenges. The ethical framework was used in this study to distil ethical dimensions that can be implemented in the water sector to guide decision and policy making. The ethical framework recognises the interconnectedness of the SES components, and in this regard, the SES components must receive equitable attention in decisions, policy making, management, protection and

governance. The current study also explored the value of equity in addressing water problems in the catchment, whereby effective implementation of the SDC instruments can help solve the challenge of illegal water use and pollution caused by the key institutional water users within the catchment.

7.3 Recommendations

For policy and water resource management:

- The ethical dimensions of water governance challenges raised in the current study should be taken into consideration when it comes to decision-making and water resources management. Implementing and incorporating principles of the systemic-relational ethics into policy making and water resources management will yield sustainable, efficient, and equitable use and management of water resources. The systemic-relational ethics recognises the interconnectedness of the components of the social-ecological system and therefore water policy should be guided by the principles of the ethical framework.
- The concept of values and ethics is not clear to the stakeholders and key institutional water users in the lower section of the Upper Vaal River Catchment, and if values and ethics should contribute to the management of water resources, the stakeholders must be educated on the two concepts.

General:

- The introduction and reaffirmation of virtue, ethics, and *ubuntu* moral theory should take place at an early stage in people's lives by incorporating the concepts into the school curriculum.

Future research:

- Further research is required on the ethical implications of water governance challenges with reference to other case studies and how the ethical framework can be incorporated in the decision-making process of water resource management and governance.

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Appendices

Appendix 1: Documents reviewed for document analysis

Appendix 1a: Vaal Barrage Catchment Management Forum minutes reviewed for document analysis (Source- https://www.reservoir.co.za/viewforum.php?f=10)

Year	Blesbokspruit Forum minutes	Leeu-Taaiboschspruit Forum minutes	Klip Forum minutes
2002	15 May	31 January	6 November
	13 November	24 April	
		25 July	
		31 October	
2003	13 May	23 January	13 May
	13 November	24 April	12 August
		27 July	11 November
		23 October	
2004	13 May	22 January	17 March
	11 November	22 April	10 August
		29 July	9 November
		21 October	
2005	10 February	27 January	11 May
	19 May	4 August	10 August
	18 August	27 October	9 November
	10 November		
2006	9 February	2 February	10 May
	18 May	11 May	2 August
	18 August	3 August	1 November
	9 November	22 November	
2007	8 February	1 February	7 February
	17 May	10 May	9 May

	16 August	2 August	1 August
	8 November	1 November	7 November
2008	7 February	14 February	6 February
	8 May	15 May	7 May
	7 August	14 August	6 August
	6 November	13 November	4 November
2009	7 May	14 February	4 February
	6 August	14 May	6 May
	5 November	13 August	5August
		12 November	4 November
2010	4 February	25 February	3 February
	6 May		4 May
	4 November		2 November
2011	3 February	25 February	1 February
	5 May	26 May	3 May
	3 November	25 August	2 August
		10 November	1 November
2012	2 February	9 February	22 May
	24 May	17 May	7 August
	8 November	16 August	6 November
		15 November	
2013	7 February	16 May	5 February
	9 May	15 August	7 May
	8 August		6 August
	7 November		5 November
2014	6 February	13 February	14 February
	8 May	15 May	6 May
	7 August	15 August	5 August
		13 November	4 November

2015	5 February	14 May	3 February
	7 May	13 August	5 May
	6 August	11 November	4 August
	5 November		3 November
2016	4 February	12 February	2 February
	5 May	12 May	3 May
	4 August	11 August	2 August
	3 November	10 November	1 November
2017	2 February	9 February	13 January
	4 May	11 May	2 May
	3 August	10 August	1 August
	2 November	9 November	31 October
2018	8 February	15 February	6 February
	10 May	17 May	8 May
	8 August	16 August	7 August
	8 November	15 November	6 November
2019	7 February	14 February	5 February
	9 May	16 May	7 May
	8 August	15 August	6 August
	7 November	14 November	5 November
2020	6 February	13 February	4 February
	6 August	13 August	4 August
	5 November	12 November	3 November
2021	4 February	11 February	2 February
	6 May	13 May	4 May
	5 August	12 August	3 August
	4 November	11 November	2 November

Appendix 1b: Government reports

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Green Drop National Report. (2022). Green drop certification waste water service regulation, *Department of Water and Sanitation*, Republic of South Africa

South Africa Human Rights Commission (SAHRC). (2021). Final Report of the Gauteng Provincial Inquiry Into the Sewage Problem of the Vaal River. February.

Appendix 1c: Published research articles and theses

Author/s	Title	Year
Braune E & Roger KH	The Vaal River catchment: Problems and research needs	1987
du Plessis A	Necessity of making water smart for proactive informed decisive actions: A case study of the Upper Vaal Catchment, South Africa	2021
Ginster M, Gouws C, Maki H, Mathipa R, Motloung S, Nyandoro M & Tempelhoff JWN	Views on unlawful water abstractions along the Liebenbergsvlei River, South Africa	2010
Hallowes D & Munnik V	An NGO's report on pollution and its effects in the Vaal Triangle	2006
Mamabolo MF	Effects of cooperative governance in the sewage treatment works in the upper Vaal River	2012
Tempelhoff JWN , Ginster M , Mahabir S , Mthembu N ,Jaka H, Kruger A , & Nkomo L	Special case study on wastewater management perspectives from below on Emfuleni's wastewater woes: In search of resolving a wicked problem	2019
Tempelhoff JWN, Munnik V & Viljoen	The Vaal River Barrage, South Africa's hardest working water way: an historical contemplation	2007

Appendix 1d: Media reports

- Eskom, Sasol warn on Vaal water supply, (https://www.iol.co.za/business-report/companies/eskom-sasol-warn-on-vaal-water-supply-1258708).
- Municipalities in Gauteng owe R5.3 billion to Rand Water, but usage increases, (https://www.news24.com/news24/southafrica/news/municipalities-in-gauteng-owe-r53-billion-to-rand-water-but-usage-increases-20221022).
- No accountability for Vaal River crisis, SAHRC report reveals, (https://www.thesouthafrican.com/news/vaal-river-crisis-sahrrc-releases-report/)
- No end in sight to Vaal River sewage problem, (https://infrastructurenews.co.za/2022/01/18/no-end-in-sight-to-vaal-river-sewage-problem/)
- People living close to the Vaal Dam suffer from diarrhoea and the long-term effects of mining and industrial pollutants include cancer, (https://mg.co.za/article/2015-07-23-sewage-in-gautengs-drinking-water/).
- Sewage poisons the Vaal River, (https://mg.co.za/environment/2021-05-02-sewage-poisons-the-vaal-river/).
- Troops battle Vaal sewage 'invasion', (https://www.timeslive.co.za/sunday-times/news/2018-12-02-troops---battle-vaal--sewage-invasion/).
- Vaal River pollution is beyond acceptable levels: SAHRC Commission asks national government to step in urgently, (https://www.timeslive.co.za/news/south-africa/2021-02-17-vaal-river-pollution-is-beyond-acceptable-levels-sahrc/).
- Vaal River pollution will take at least three years to fix, says department, (https://www.timeslive.co.za/news/south-africa/2020-09-23-vaal-river-pollution-will-take-at-least-three-years-to-fix-says-department/).

Appendix 2: Workshop

Appendix 2a: Workshop invitation

WORKSHOP ON ETHICS AND WATER GOVERNANCE IN THE LOWER SECTION OF THE UPPER VAAL (on 21 August 2019 at the Sarabi Country Lodge (372 Fernandes St, Bredell AH, Kempton Park).

This WRC-funded project on the contribution of ethics to water governance in South Africa arises out of the realisation that a range of the water governance challenges that currently confront South Africa have serious ethics dimensions, and thus surfacing value systems that underpin claims to water resources, and the way water is govern may help make contribution to addressing some of the water governance challenges through a critical analysis of the ethical implication of decision-making processes that affect people and the environment in relation to access to water, and ecosystem protection.

South Africa is confronted by deeply embedded poverty, inequality, and social and environmental injustices that all have serious ethical implications for the way in which water ought to be govern, particularly in terms of allocation, access, equity, sustainability and the protection of ecosystems. The achievement of an ethically grounded approach to water resource governance and management would require a fundamental shift in terms of managerial attitude and policy, particularly with regard to balancing and trading off of values that influence criteria for just water allocation to both society and the environment. To interrogate what an ethics approach can contribute to water resource governance in South Africa, two case studies have been selected i) catchments within the lower sections of the Upper Vaal River system and ii) the ow er Sunday's River Catchment.
The project team will be holding a one-day workshop on **21 August 2019**, in which it will hold presentations and discussion on:

i) Ethics and water governance in the Lower section of the Upper Vaal River catchment
ii) Water governance challenges in the Lower section of the Upper Vaal River catchment
iii) Causes and effects/implications of water governance challenges in the Lower section of the Upper Vaal River catchment.

iv) How such challenges may be address (what needs to be done).
v) Possible ethical implications and dimensions of such challenges.
Workshop Programme Starts at 9am and ends at 3:30pm Time Activity
Facilitator/Presenter 9 – 9h15 Tea Meet and greet
9h15 – 9h30
Introduction
Each workshop participant is given a sticker and are asked the following questions:
) What does ethics and value mean to you?
ii) What are the main benefits you/or the sector in which you work want from the water resources of the lower section of the Upper Vaal?
iii) Why do you want those benefits?
iv) Are these benefits currently being supplied in ways that are satisfactory to you? If not why?
9h30 – 9h45
Setting the scene – ethics and water governance (introducing the project)
9h45 – 11h00

Group conversation café

Workshop participants will be divided into groups and each group will discuss the following issues;

Water governance challenges in the study catchment (i.e. what are the water governance challenges in the catchment?)

Causes and effects of the challenges (What are the causes
and effects of the identified water governance challenges?)

How such challenges may be address (what needs to be done to address the challenges?)

Possible ethical implications of the identified challenges in the catchment

What does ethics and value mean.

1 – 2 pm Lunch

2 – 3:30 pm Group report back and plenary discussion

Each group report back and workshop participant discuss emerging
issues/insights/perspectives from each group

Nominated group representative

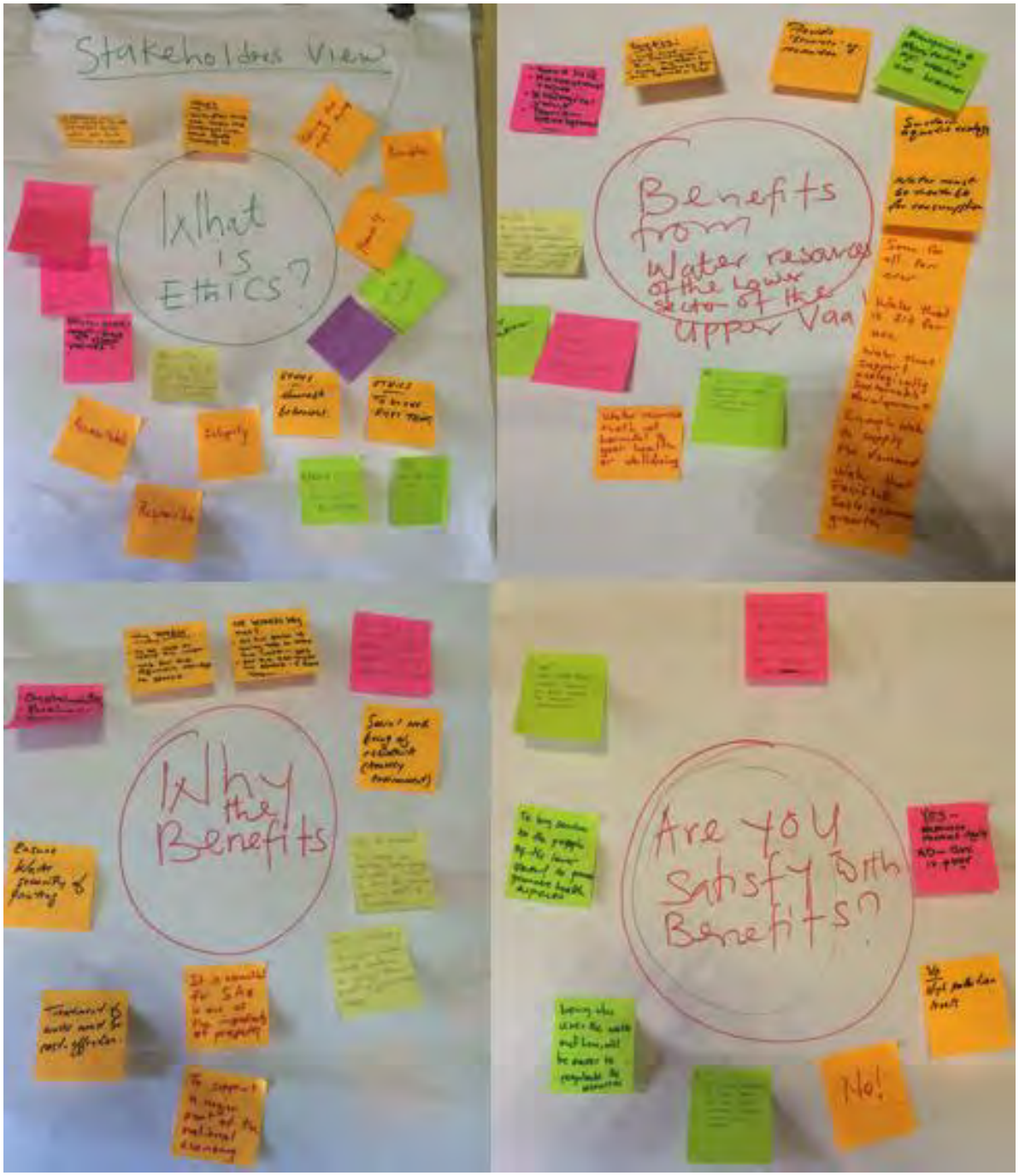
3:30 pm Closure

Who should come and why This is a knowledge production and synthesis workshop aimed at exploring critical water governance challenges in the study catchment and ways in which ethics can contribute to addressing some of the identified challenges.

The workshop is open to regulators (DWS, CMA, WUA), researchers, policy makers, NGOs and water resource users, communities living in and/or interested in the catchments, CMF members etc.

Catering purpose: RSVP by 20 August 2019.

Appendix 2b: Responses from workshop participants



Appendix 3: Key informant interview questions

The National Water Act considers stakeholder participation, equity, sustainability, accountability and efficiency as fundamental to water resource management in South Africa.

1) Please tell us your experience of what is being done to ensure that there is equity in the management of water resources in the Lower Section of the Upper Vaal River catchment
2) Please tell us your experience about the challenges of equitable allocation of water resources in the Lower Section of the Upper Vaal River catchment
3) Please tell us your experience of what is being done to ensure efficient management of water resources in the Lower Section of the Upper Vaal River catchment.
4) What do you consider as the main challenges about efficient management of water resources in the Lower Section of the Upper Vaal River catchment?
5) Please tell us your experience of what is being done to ensure the protection of water resources in the Lower Section of the Upper Vaal River catchment.
6) What do you consider as the main challenges about protecting water resources of the Lower Section of the Upper Vaal River catchment?
7) Based on your experience in the Lower Section of the Upper Vaal River catchment, would you consider one of these values (i.e. equity, efficiency and sustainability) as receiving more attention in terms of water resource management?
8) Apart from equity, sustainability and efficiency, what are the other key values/principles that inform water resources management in the Lower Section of the Upper Vaal River catchment?

Water governance systems
9) A catchment Management Agency (CMA) is being established in the Lower Section of the Upper Vaal River catchment, what do you consider as the most important function of the CMA and Catchment Management Forums (CMFs)?
10) Do you consider the current governance structure/institutional arrangement for water resources management in the catchment adequate and effective? If not, what do you consider can be done?
11) What do you consider as the main water governance challenges in the Lower Section of the Upper Vaal River catchment?
12) What do you consider as the solution(s) to the water governance challenges?