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An analysis of sustainability of communally-managed rural water supply systems in Zimbabwe

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A thesis submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Department of Earth Science, University of the Western Cape

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KEY WORDS

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ABSTRACT

Sustainability of rural water supply systems is a major development challenge in most developing countries including Zimbabwe. This thesis aimed to analyse the sustainability of communally managed rural water supply systems in Zimbabwe. Specifically, it determined the factors influencing sustainability of water supply systems; investigated how the implementation of Community Based Management (CBM) is contributing to the sustainability of water supply systems; explored how multiple uses of water influence sustainability of water supply systems under CBM and determined how the principal factors influencing sustainability and the CBM implementation practices, can be incorporated at the different stages of the development of a water supply system. The study was done in Nyanga, Chivi and Gwanda districts. A total of 399 communally- managed water points were studied and 300 households participated in the study. Questionnaires were used to collect data from households and Water Point Committees (WPCs). Data was also collected using Key Informant Interviews (KIIs) with a total of 33 key informants being drawn from the national, district and community levels. Two Focus Group Discussions (FGDs) per district were conducted targeting the local leaders, Village Pump Minders (VPMs) and Village Health Workers (VHWs). The other methods of data collection which were used are participatory observations, document analysis and participatory research. A number of methods were used to analyse the data. Quantitative data collected through questionnaires were analyzed with the help of the Statistical Package for Social Science (SPSS version 22). Descriptive statistics such as means, maximum, minimum, standard deviations and frequencies were used to provide a concise summary on the socio-economic status of respondents and various sustainability factors. Multi Criteria Analysis (MCA) was used to determine weights of sustainability factors while Exploratory Factor Analysis (EFA) was used to determine the principal factors influencing sustainability. The independent samples t-test was used to assess differences in sustainability performance between water points which were used for multiple uses of water, and those which were used for domestic purposes only. The paired samples t-test was used to assess differences in sustainability performance of water points between the pre-garden period and the during-garden period. Qualitative data was analysed using the thematic approach. The study findings show that sustainability of water supply systems is a challenge in the rural areas of Zimbabwe, with an average of 33% water points being unsustainable. The

sustainability levels varied from one district to another. The factors that influenced sustainability are technical, social, institutional, financial and environmental. Under the technical factors, sustainability is influenced by the type of water lifting device, availability and affordability of spare parts, functionality of water points and pump status. The social factors which had an influence on sustainability are the ability to manage conflicts, community participation in planning, and in Operation and Maintenance (O&M). Sustainability was also influenced by the institutional factors such as existence of user committees, functionality of user committees, the level of external support and training in CBM. With regard to financial factors, sustainability was influenced by the presence of O&M fund, regularity of making financial contributions, adequacy of O&M funds and availability of rules on fee collection. Water quality at source and reliability of water supply were the environmental factors which had an impact on sustainability. The implementation of the CBM approach at the district and community levels was not according to the guidelines provided by the CBM framework. Poor coordination within the institutions in the rural water supply sector contributed to the dichotomy of theory and practice in the implementation of the approach. Lack of financial resources within government institutions had an impact on how CBM requirements were implemented. Since most rural water projects were funded by Non-Governmental Organizations (NGOs), the organizations' strategies and objectives were taking precedence over CBM guidelines which also negatively impacted on technical, social and institutional factors of sustainability. This resulted in weak community institutions whose practices were diverging from their stipulated roles. Multiple uses of water such as community gardening and livestock watering had an influence on social, technical, institutional, and financial factors. There were statistically significant differences in sustainability performance between water points used for multiple uses of water and those used for domestic uses only. Generally, water points used for multiple uses were more sustainable than those which were used for domestic purposes only. However, frequencies of water use conflicts and water point breakdowns were generally higher where multiple uses of water where practised than were the practice was not there. The study also established that the relative importance of the productive uses of water to the communities determines whether water points will be maintained and sustained. Another key finding of the study is that principal factors of sustainability and the best CBM implementation practices can be incorporated at different stages of a water supply project. The effective participation of different stakeholders in the rural water

supply sector is indispensable for sustainability to be achieved when addressing sustainability factors at each stage of project development. The study concluded that sustainability of water supply systems is influenced by economic, social, technical, environmental and institutional factors. It was also concluded that, the discrepancies in the CBM theory and practice in the Zimbabwe's rural water sector is negatively influencing sustainability. However, multiple uses of water had a positive impact on the overall sustainability of water supply systems. The study recommends that, principal factors of sustainability and the best practices in implementing CBM have to be incorporated at different stages of developing water supply projects to promote sustainable water supply.

DECLARATION

I declare that this thesis *''An analysis of sustainability of communally-managed rural water supply systems in Zimbabwe''* is my own work. All other sources, used or quoted, have been indicated and acknowledged by means of complete references. This thesis has not been submitted for a degree at another university.

Tendai Kativhu

Signature Date 04/08/2017

DEDICATION

To my special parents Mr and Mrs Demberere.

To my beloved husband Zivanai, my daughter Panashe and my son Ngonidzashe, this dedication is a symbol of appreciation for their love, care, peace, tolerance and support during my absence which sustained me throughout this academic journey. I thank you and love you with all my heart. To my children, mummy has set the standard.

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LIST OF ABREVIATIONS

AHP	Analytic Hierarchy Process
ADB	Asian Development Bank
AfDB	African Development Bank
BOT	Built Operate and Transfer
BOOT	Built Operate Own and Transfer
CBM	Community Based Management
CBNRM	Community Based Natural Resources Management
CBOs	Community Based Organisations
CFA	Confirmatory Factor Analysis
DA	District Administrator
DDF	District Development Fund
DFID	Department for International Trade
DMT	District Maintenance Team
DRA	Demand Driven Approach
DWSSC	District Water and Sanitation Sub-Committee
EFA	Exploratory Factor Analysis
ESAP	Economic Structural Adjustment Programme
FGD	Focus Group Discussion
GoZ	Government of Zimbabwe
IDWSSD	International Drinking-Water Supply and Sanitation Decade
IK	Indigenous Knowledge
IMF	International Monetary Fund

IRWSSP	Integrated Rural Water Supply and Sanitation Programme
IWSD	Institute of Water and Sanitation Development
KIIs	Key Informant Interviews
MCA	Multi-Criteria Analysis
MDGs	Millennium Development Goals
MUS	Multiple Use System
NAC	National Action Committee
NCU	National Coordination Unit
NGOs	Non-Governmental Organizations
O&M	Operation and Maintenance
PPPs	Public Private Partnerships
RDCs	Rural District Councils
RWSN	Rural Water Supply Network
SDA	Supply Driven Approach
SDGs	Sustainable Development Goals
SLA	Sustainable Livelihoods Approach
SL	Sustainable Livelihoods Framework
SPSS	Statistical Package for Social Sciences
UN	United Nations
UNICEF	United Nations Children's Fund
UNDP	United Nations Development Programme
VHW	Village Health Worker
VPMs	Village Pump Minders
VWSSC	Village Water and Sanitation Sub-Committee
WASH	Water Sanitation and Hygiene

WAS	Waniata Air dan Sanitasi
WPCs	Water Point Committees
WSP	Water and Sanitation Programme
WWSSC	Ward Water and Sanitation Sub-Committee
WEDC	World Commission on Environment and Development
ZimVAC	Zimbabwe Vulnerability Assessment Committee
ZimStat	Zimbabwe National Statistical Agency
ZWP	Zvishavane Water Project

1. INTRODUCTION

1.1 Background

The provision of safe drinking water is a crucial component for the world to eradicate poverty and improve public health. As part of the Millennium Development Goal (MDG) 7, halving the proportion of people without sustainable access to safe drinking water, and basic sanitation by 2015 was one of the targets (UNDP 2015). Although it was declared that the drinking water part of the goal was met (Unicef & World Health Organization 2012), this is not true globally as some regions still lag behind (WHO/UNICEF 2015). Huge disparities in accessing improved water sources have been reported both between and within regions and countries. For example, 91% of the global population has been reported to be accessing improved water sources against 68% recorded in the sub-Saharan Africa region. Notably, of the 663 million people who were still lacking improved drinking water sources in 2015, nearly half of them live in sub-Saharan Africa. Another disparity in improved water access has been noted between the urban and the rural populace. Globally, the rural populace has lower access (84%) than their urban counterparts (96%) (WHO/UNICEF 2015). These disparities have resulted in communities in rural sub-Saharan Africa to be the most affected as far as accessing improved water sources is concerned.

It is also worthwhile to note that the declaration of success on the attainment of the drinking water goal ignores two key components of water supply, which are provision of safe water and maintaining sustainable supply systems (Alexander et al. 2015). Drinking water quality is a public health concern as 90% of child deaths are directly linked to contaminated water, lack of sanitation, and inadequate hygiene (UNDP 2015). A proxy, the proportion of people using ‘improved water sources’ has been used to refer to water quality instead of the actual testing on physical, chemical and biological parameters (WHO & UNICEF 2012). A report by UNDP (2011) showed that water samples obtained from many improved water sources especially from developing countries, did not meet the microbiological standards set by the World Health Organisation (WHO) thus threatening public health. The situation is worse in the sub-Saharan Africa where a significant proportion of the population use rivers, lakes, ponds and irrigation canals as their main source of water (WHO/UNICEF 2015). Where improved water sources have been installed, water quality testing is often not performed due to costs. This is a clear indication that, despite the global improvements in water access, the sub-Saharan Africa region still bears the burden of poor water quality and access.

Apart from the water quality, sustainability concerns have also been raised against the declared success on meeting the drinking water part of the goal. To meet part of the goal, literature has shown that development practitioners in the sector were putting more attention on building new facilities than ensuring their sustainability (Katz & Sara 1997; Montgomery et al. 2009). Little investments have been done in operation, maintenance and repairs of the installed infrastructure (Hutton & Bartram 2008). It has been estimated that only 5-20% of the total water supply project costs are allocated for O&M against the recommended 60% for water supply systems to be sustainable (Hutton & Bartram 2008). Limited or absence of maintenance budgets has compromised sustainability thus depriving communities of the benefits of improved water systems. In September 2015, the UN General Assembly developed a stand-alone water goal (number 6), "Ensure the availability and sustainable management of water and sanitation for all" in its Sustainable Development Goals (SDGs) (United Nations 2015). This development shows that sustainability of water supply systems is still a challenge even after the MDGs.

1.2 Sustainability in context

The concept of sustainability took its root from the debate on sustainable development during the early 1970s. Sustainable development was defined by the World Commission on Environment and Development (WEDC) as development which meets the needs of the present without compromising the ability of future generations to meet their own needs (Brundtland 1987). The definition by Brundtland (1987) has been widely used in the sustainable development literature, however, the concept has been criticized for being elusive and having different interpretations (Hove 2004). Lyytimäki & Rosenström (2008) argued that sustainable development is too multifaceted, complex and dynamic to be captured by any single framework. Despite these critiques the vocabulary of "sustainability" was speedily adopted by development theorists and practitioners including those concerned with water and sanitation.

Parry-Jones et al. (2001) argued that the term became a buzz word as it is a prerequisite for inclusion in most water supply and sanitation project proposals. This resulted in different groups of people having different perceptions of sustainability based on the relative value of achieving their various goals (Lockwood 2002). Donors and government agencies focused on economic indicators of sustainability, civil society and development institutions on project, managerial or social indicators while often users are mainly concerned about the flow of benefits and convenience. Though there is no consensus on the precise components of sustainability, it is widely agreed that any conception of sustainability must account for the interconnections of environmental, economic, and social factors (Milman & Short 2008).

In the Water Sanitation and Hygiene (WASH) sector, numerous scholars have tried to come up with specific sector-oriented definitions of sustainability (WELL 1998; Carter & Howsam 1999; Dayal et al. 2000; Parry-Jones et al. 2001; WaterAid Tanzania 2009). These definitions have a number of common recurring issues which include reliability and adequacy of water supply, provision of services of an acceptable quality and local financing of services for O&M. The working definition of this study which states that, "a water service is sustainable if the system is maintained in a condition that ensures reliable and adequate water supply, and benefits of the supply continue to be realized by all users" has been developed based on the most recurring issues in the literature on sustainability. Studies have shown that, unsustainable water supply systems usually have long downtimes, high breakdown frequencies, inadequate water supply and are unreliable (Aguasan 2008; Opare 2011; Adams 2013; Amjad et al. 2015).

How sustainability is defined is important in setting the parameters which are used to measure it and in understanding the determinant factors which may contribute to, or work against, the achievement of sustainability (Lockwood 2002). A wide range of factors have been noted to be influencing sustainability of water supply services (Whittington et al. 2008; Montgomery et al. 2009). These factors have been mainly categorised as technical, social, financial, environmental and institutional and they will be discussed in Chapter Two of this thesis. Their impact on sustainability is context specific hence the need to understand how they influence sustainability at local levels for appropriate solutions to be developed.

1.3 Community participation in rural water supply

The word "community" has been defined in different ways in literature. The definition that is mostly used is by McMillan & Chavis (1986) which states that, a community is a social group that inhabits a common territory and having one or more additional ties. In water supply studies a community has been viewed based on geographical criteria and as such it has been used synonymously with a village (Doe & Khan 2004). In this study the definition by Anschutz (1996) which states that a community is a group of water users who live in the same area and have access to, and use the same water source will be used. The adoption of this practical definition avoids the tendency of being caught up in the definitions of community that embrace social and cultural meanings of the concept, which are not applicable to the nature of the present study.

The emergence of participation as an approach to development was in part a response to the collapse of the credibility of 'grand theories' of development in the 1970s and 1980s (McPherson & McGarry 1987). This saw the concept being applied in developing countries under labels such as 'people's participation`, 'public involvement`, 'community participation`, 'social mobilization`, 'self-help development`, and 'grassroots development` in a number of development projects including rural water supply systems (Bastian & Bastian 1996, in Riley 2009). The concept became a prerequisite for donor funded project proposals as it was deemed to solve the sustainability problems of water supply systems. Community participation is defined as a process by which individuals, families or communities assume responsibility for local problems and develop a capacity to contribute to their own community development (Singh 2006). This definition shows that there was a radical change in the lens of development practitioners and donors as beneficiary communities were no longer seen as recipients of services but as major stakeholders in the development process.

Authors have noted that community participation in the rural water sector may include expressing demand for a water source, provision of free labour, selection of technology and attending meetings (Black 1998; Carter & Howsam 1999; Gleitsmann et al. 2007). Despite the existence of different forms of participation, Harvey & Reed (2007) argue that community participation should not be tokenistic for sustainability to be achieved. Instead effective community participation should be promoted starting as early as possible during problem identification.

Harvey & Reed (2007) indicated that community participation can be stimulated by the community itself or by others, and it begins with dialogue among members of the community about how issues are decided, and to provide an avenue for everyone to participate in decisions that affect their lives. Work by Marks et al. (2014) revealed that projects which involve the widest possible participation of people whose needs are addressed are most likely to be sustainable. In the rural water sector, the question that may then be posed then is, are women and marginalized groups given the platform to participate? This is because, several studies have shown the importance of women's participation in rural water supply systems (Manikutty 1997; Lammerink 1998; Ladele & Tackie-Ofosu 2013). However, a cautious voice by Aladuwaka & Momsen (2010) said that, women should not participate especially in technical issues, only to pursue gender equality. When carefully looked at, this does not contrast with the need to involve women in water management, however, it is an advocacy that women should be capacitated with the right skills for desired outcomes to be achieved.

Mansuri & Rao (2013) observed that participation of women is failing due to elite capture. Aladuwaka & Momsen (2010) concluded that although women occupied senior positions in Water Point Committees (WPCs), their participation was nominal as major decisions were made by men especially those in leadership positions. Evidence from Sierra Leone also showed that, major efforts to foster participation in decision-making by women had no long-term effects as male elders and chiefs retained just as much control as in places where there had been no such efforts (Miguel et al. 2012). Chowns (2014) also made similar observations in Malawi where women were found not to be actively involved in decision making under community management programmes. These findings indicate that participation of women in decision making may still be wishful thinking in the rural water supply sector due to local power, political and social dynamics in different areas.

The participation of women in decision making has been contested by Moyle et al. (2006) who states that participation can bring about differential burdens on women as they will still be responsible for major activities at home even after being empowered in decision making in community affairs. Supporting Moyle's contestation, Kavita (2012) argued that time is not available for women to enable them to participate fully in decision-making both at the household and community levels. Putting women in decision making was therefore considered to be done to meet donor requirements for funding to be channeled towards water supply projects. Therefore, considering the burden that women bear in developing countries when they are excluded from decision making about water supply projects, these arguments have been considered to be pertinent (Lockwood 2004). Field evidence has shown that at the community level, women are more committed and participate more than men in rural water projects (Ladele & Tackie-Ofosu 2013; Demberere et al. 2015).

Evidence from several studies has shown that community participation has a positive impact on sustainability factors. Kleemeier (2000) found that, participation played a critical role in keeping small-scale piped water schemes functioning in Malawi. Ishamn et al. (1995) in their study of 121 rural water projects also concur that, community participation increases sustainability. Based on statistical analysis of their results they found that 'beneficiary participation was the single most important factor contributing to project effectiveness' (Ishamn et al. 1995). A study by Prokopy (2005) had the same conclusions that, participation through contributing to capital costs and household involvement in decision making was positively associated with project outcomes in India.

In Zimbabwe Hoko et al. (2009) reported high percentages of non-functional water points in some wards of Mt Darwin District due to poor community participation. Their results were in agreement with the findings in Tunisia (Manikutty 1997). The results showed that a potable water project suffered because of lack of community participation. In two other case studies by Isham & Kähkönen (1999), the Agathi Rural Water Supply in Kenya and the Waniata, Air dan Sanitasi (WAS) in Indonesia, the two projects were first implemented without community participation and ran into difficulties and then improved their performance after community participation was introduced. With these field findings it can be concluded that, community participation enhances sustainability of water supply systems. This supports the argument by Harvey & Reed (2007) that community participation is indispensable and it is a prerequisite of sustainability. However, Cleaver (1999) indicated that, community participation should not be taken as an act of faith in development, where it is failing it needs to be questioned for sustainability to be enhanced.

1.4 Community management

Communities are involved in the management of several natural resources such as water, wildlife, land and forestry. Globally, Community Based Natural Resources Management (CBNRM) has been viewed as the most sustainable way of managing natural resources (Brundtland 1987). Gadgil et al. (1993) noted that communities are involved in the management of natural resources because of the need to use Indigenous Knowledge (IK) as well as people's vital opinion for the management and preservation of the resources.

With a thin line having been drawn between community participation and community management in literature, community management is one of the key ways in which the theory of participation has been operationalized (Kleemeier 2000; Harvey & Reed 2004; Prokopy 2005) In literature the two have been used interchangeably (Lockwood 2004). However, in practice community participation has been seen to be a consultative empowerment process while community management is more concerned on how communities have authority and control over development (Quin et al. 2011). Despite the differences and similarities of the two approaches, the literature has shown that these approaches have not been delivering in practice as they are theorized.

Community management refers to the capabilities and willingness of the beneficiaries to take charge and determine the nature of development affecting them. In the water sector, Schouten et al. (2003) defined community management as when a community takes a range of management tasks related to maintaining (and in some cases developing) a domestic water supply. These tasks include, setting tariffs, collecting payment, carrying out routine maintenance, and making decisions about system's extension. Schouten et al. (2003) also described community management as a situation where communities make strategic decisions and choices regarding the level of service they want, how they want to pay for it and where they want it. However such choices have been found to be theoretical in community management of rural water supply services since communities are normally found at the receiving end of the services (Harvey & Reed 2004).

The dominance of community management in the rural water sector was enshrined in the 1990 Delhi Statement and the 1992 Dublin Principles (Gonzalez-Villarreal & Solanes 1999; Ghosh 2012). The third principle of the New Delhi Statement states that, "community management is a key to sustaining services for the rural poor and is a viable option for poor urban settlements. Many governments responded to this principle by developing policies that promote management of water services at the lowest possible level (Katz & Sara 1997; Butterworth et al. 2010; Hubbard et al. 2011). The guiding principle of Agenda 21 adopted during the United Nations Conference on Environment and Development (UNCED) in 1992 Rio de Janeiro, and 2002 World Summit on Sustainable Development in South Africa also emphasize the importance of community management of services backed by measures to strengthen local institutions in implementing basic service programmes (Doe & Khan 2004). In this regard, Smits et al. (2013) questioned the capacity of governments in developing countries to provide support that strengthens local institutions. Literature has shown that where local institutions are not given support, community management fails (Komives et al. 2008; Bakalian & Wakeman 2009).

The rationale behind community management is to empower communities to take control of their water services (Carter & Howsam 1999; Lockwood & Le Gouais 2011). Empowerment has to be done through training in Community Based Management (CBM) since community management requires the formation of new structures at community, district and national levels. In theory the people who occupy positions in those structures should be empowered with the necessary skills for sustainability to be achieved (Evans & Appleton 1993). In support of this Carter & Rwamwanja (2006) noted that empowered institutional frameworks are critical when communities are to manage their own water resources. However in practice, literature suggests that this has not been the case since people have been taking on new responsibilities without the required skills (Jones et al. 2012). Resultantly, weak institutions have been common under community management.

There have been debates that community management disempowers communities at local level against its claims of empowering them. Chambers (1994) noted that strategies under community management have to be flexible and locally relevant for communities to take control of their own destinies. On the same note, Harvey & Reed (2004) also argued that communities should be given choices as to how their water services are to be managed depending with the local context. However, the policy of community management is not flexible to cater for the uniqueness of different localities where it is applied. Furthermore all decisions regarding technology are determined at the national level with little room for local needs (Harvey & Reed 2007). This has resulted in communities being given technologies that they do not have the financial and technical capacity to maintain (Parry-Jones et al. 2001; Montgomery et al. 2009). The reasons why community management has been failing to deliver as expected in water supply projects are discussed in Chapter Two.

1.5 Community Based Management (CBM) in Zimbabwe

In Zimbabwe, community management of natural resources and water in particular can be traced back to the pre-colonial era when traditional communities organised along clan leaders were able to provide for the basic needs of the people. The high level of social cohesion and unity which characterised the communities, enabled community management of natural resources. Taboos and common property formed part of the important strategies which were used to manage natural resources including water sources (Mawere 2013). Several taboos were used to conserve and manage drinking water sources in Zimbabwe which include the following:

Usaraura mutsime (Do not fish in a well). The consequence of violating this taboo was that the well will dry up which was indeed a curse to the entire community. Perpetrators were severely punished once caught. In reality, fishing from a well will in most cases result in contamination of the drinking water source.

Usaitira tsvina mutsime (Do not excrete in a well). The consequence for violating this taboo was that the perpetrator will suffer from bilharzia. It is a truism that everyone desires good health. Since the consequence was undesirable to the perpetrator and the entire community when the contaminated water would have been consumed, people were obliged to avoid vicious characters that caused ill health (Mawere 2013). According to Ndlovu & Manjeru (2014) other taboos which were used in water supply management are denying people to draw water from a drinking water source using any blackened containers, for example containers which are used to boil water on fire. People were also denied to bath or do laundry close to drinking water sources. These taboos in reality were meant to manage water sources by controlling water pollution and protecting public health.

Common property is another strategy that was used to manage natural resources in pre-colonial times. The strategy ensured responsibility and participation by all community members in the management and conservation of resources and water sources in particular (Mawere 2013). Common property rights dictate that all members of the group have the rights that they may not be excluded from utilizing the resources that belong to them as a group (Agrawal 2001). This created a strong sense of responsibility and sustainable use of water sources given that everyone considered himself/herself a beneficiary and owner of the resource. However the common property regime as a management strategy has been criticized for the fate it has caused through the "tragedy of the commons" (Hardin 1968). Despite the fate caused on water sources, Mawere (2013) disputed the theory of tragedy of the commons stating that, the contribution made by the common property strategy in natural resources management should not be underestimated.

The collective approach to water management remained in force till the onset of colonialism. However, the advent of colonialism and the influence of Western 'civilization' introduced a centrally controlled welfare system of water governance in Zimbabwe and other African countries. In Zimbabwe, the coincidence of the country's independence with the start of the International Drinking Water Supply and Sanitation Decade (IDWSSD) (1980-1990) provided an ideal basis for the rapid expansion of the country's rural water and sanitation infrastructure (Robinson 2002). The government established the Integrated Rural Water Supply and Sanitation Programme (IRWSSP) which was implemented between 1985 and 2005 (Institute of Water and

Sanitation Development 2000). The programme had a great emphasis on the development of rural areas particularly the communal and resettlement areas to redress the imbalance of the former colonial powers. The government made some notable improvements in the provision of water and sanitation in rural areas under the IRWSSP. By 1988, 84% of Zimbabwe's population had access to safe drinking water (Institute of Water and Sanitation Development 2000). In rural areas, it was noted that from 1980-2002 there was a commendable increase in facilities overall from 5% to 39% in terms of sanitation and 30% to 78% in terms of water supply (WSP 2015). However, it was noted that the massive financial injection into the development of water facilities was not matched with a corresponding O&M package and community empowerment initiatives (Robinson 2002).

Maintenance of most water points was under a centralized system called the Three- Tier Maintenance system (Morgan et al. 2002). The system had the following structures:
First Tier: The first tier consisted of the District Maintenance Team (DMT) which was responsible for the overall O&M, planning, provision of tools and spare parts, and supervision of the second tier. The tier was also responsible for the repair of major breakdowns assumed to be beyond the capacity of the second tier. Members of this tier were the District Development Fund (DDF) employees.

The Second Tier: This comprised the pump minder who was a local mechanic selected by the community at ward level. He or she was responsible for all mechanical operations of the water supplies in the ward. It was assumed that the response by the pump minder to breakdowns would be much faster than the DMT as he/she was community based and had all the necessary tools and spares to undertake all repairs for water points in the ward.

The Third Tier: The Caretaker was one of the water point users, selected by the community as a member of the Water Point Committee (WPC). He/she was responsible for all routine maintenance works with the assistance of the community itself. He/she was the link between the community and the pump minder.

The three-tier O&M system was expected to achieve sustainable water supply and sanitation systems. However, this was not so due to a number of reasons (Institute of Water and Sanitation Development 2000). The system had challenges of accelerated increase in water points, continued rise in O&M costs, and increased work load for pump minders who were responsible for the repairs and maintenance of water points. In view of these problems which resulted in long downtime, the sector adopted CBM in 1997 as a sustainable management approach for the water and sanitation programme (National Action Committee 2005). The adoption of CBM was also exacerbated by the deep economic crisis which prevailed in the country in the late 1980s. The crisis made the government to adopt the International Monetary Fund (IMF) and World Bank sponsored Economic Structural Adjustment Programme (ESAP) in 1991 to rekindle investor interest and eradicate constraints to growth. According to Sachikonye (2002), ESAP stripped the state of its controlling powers in the economy and relegated it to the role of creating an enabling environment in which market forces, and not the state, would reign supreme. The programme also chipped away the socio-economic improvements that had been introduced by the government in the 1980s. Rural water provision did not escape the corrosive impact of ESAP as resources once committed to water programmes dwindled (Sachikonye 2002). This made CBM to gain more prominence as an approach to supply and manage water facilities in the rural areas of Zimbabwe. The theoretical framework and assumptions of CBM are discussed in Chapter Two.

1.6 Multiple uses of water

Rural communities with agriculture-based livelihoods depend in many ways upon water (Bakker et al. 1999; Smits et al. 2008). Water sources open up a lot of livelihoods opportunities since they can be used for multiple uses such as domestic and productive uses (Rautanen et al. 2014). However traditionally, water supply planning has focused on meeting basic domestic needs only. To achieve greater water security at local level and to tackle poverty, a more holistic and integrated approach to planning for water supply systems was needed (Cousins et al. 2006). The increased attention to the provision of water supply services to meet both domestic and productive needs culminated in the development of the concept of Multiple Use Services (MUS)

(Van Koppen et al. 2006). The approach is based on an understanding of people's livelihood strategies and the role of water resources within communities.

MUS has been defined as a participatory, integrated and poverty-reduction focused approach in poor rural and peri-urban areas, which takes people's multiple water needs as a starting point for providing integrated services, moving beyond the conventional separation of domestic and productive sectors (Van Koppen et al. 2006). This implies that MUS should include designing and planning for water supply services that will enable the provision of water for multiple uses. The MUS approach is largely consistent with the holistic approach to water services development embodied in the Dublin Statement (Smits et al. 2010b). Therefore, the MUS design and implementation guidance could provide a way to operationalize the Dublin Statement. The potential for the MUS approach to integrate domestic and productive/irrigation activities of the water sector in the context of the environment, health, and livelihoods makes it an important challenger to the WASH paradigm (Bakker et al. 1999; Hall et al. 2014)

Against this background Fielmua & Mwingyine (2015) noted that, although water provision has received much attention, integrating multiple use water systems in design and implementation has received less emphasis. This has been blamed on the sectoral approach in the provision of domestic and productive water in most countries (Van Koppen et al. 2006). The sectoral approach was found to be stemming from a policy context in which there is a distinct sharp division of water subsectors particularly the irrigation and water supply and sanitation subsectors (Smits et al. 2010a). This is despite the practice of multiple water use being fairly widespread (Bakker et al. 1999; Fielmua & Mwingyine 2015). The emergence of the MUS approach since the early 2000s therefore, sought to overcome the sectorial divides in water planning (Rautanen et al. 2014). This resulted in the approach being applauded by development theorists and practitioners for enhancing sustainability of water supply systems and tackling the multiple dimensions of poverty (Van Houweling et al. 2012; Van Koppen et al. 2014)

In Zimbabwe MUS has been practised in most rural communities (Guzha et al. 2007; Katsi et al. 2007). Although the approach has not been called as such, the government and other stakeholders in the water sector have been building up on domestic water supply programmes to cater for small scale productive uses at household and community levels (Makoni & Smits 2007). The main productive water uses that have been supported are livestock watering and gardening. In this study, productive uses are the non-domestic (i.e., livestock-watering and gardening) that rely on domestic water systems (Thompson & Cairncross 2002). On the other hand, domestic uses are the 'consumptive' uses such as drinking and cooking, as well as the 'hygiene' uses such as washing, cleaning and bathing (Thompson & Cairncross 2002).

1.7 Statement of the problem

Numerous studies have shown that sustainability of water supply systems is a major development challenge in many rural settings of developing countries including the sub-Saharan Africa region (Adams 2013; Tadesse 2013; Chowns 2014; Spaling et al. 2014; Alexander et al. 2015). Varying levels of sustainability have been reported in the rural water supply literature. Evans & Appleton (1993) observed that 30-40% of rural water supply systems in developing countries were not sustainable and the same figure was also noted by Rural Water Supply Network (2010) in Africa. Peter & Nkambule (2012) observed 33.3% unsustainable water supply systems in Swaziland, while Mwnagi & Daniel (2012) noted 42% in some rural parts of Tanzania. In Zimbabwe Hoko et al. (2009) noted that 38% of the water supply systems were unsustainable in Mt Darwin District, while Dube (2012) observed 60-70% in Gwanda District. As discussed in Section 1.2, unsustainable water supply systems usually have long downtimes, high breakdown frequencies, inadequate water supplies, and are unreliable. Such high levels of unsustainable water supply systems hinder access to potable water, considering that water is a basic human right. This also raises the question why rural water points fail and are abandoned within the very communities that desperately need them (Ihuah & Kakula 2014). Therefore, there is need to evaluate factors affecting the sustainability of water supply systems so that the long-term benefits of the investments can be achieved.

Before the 1990s water supply services in most rural communities of the world were being provided and managed by governments through the supply-driven approach (Carter 1999; Quin et al. 2011). The approach has been criticized for failing to achieve sustainability. The failure has been attributed to lack of accountability, corruption, inefficient management, and lack of financial resources as well as low prioritisation of funding the water sector (Montgomery & Elimelech 2007). Harvey & Reed (2004) blamed the failure of centrally-managed systems to lack of government capacity and commitment to maintain rural water supply services. These criticisms may be heavily based on ideological orientation as there is evidence that central government interventions have been delivering in some areas (World Bank Water & Sanitation Program 2002). According to Carter & Howsam (1999) the failures of the centrally-managed system has resulted in the adoption of participatory approaches deemed to be a solution to the low sustainability of centrally-managed rural water supply services. Neo-liberal policies of the 1990s further shifted attention from participation to local governance (Khanal 2003). This resulted in the adoption of the CBM approach in the management of rural water supply throughout the international development sector. In Southern Africa, CBM has become the prevalent approach for management of rural water supply (Harvey & Reed 2004). However, the approach has not always been successful in ensuring the sustainability of water supply services (Quin et al. 2011). This is because where CBM has been adopted, water supply systems are still not sustainable hence the need to understand how the implementation of the approach is influencing sustainability.

Zimbabwe, like other developing countries also adopted the CBM approach in implementing and managing rural water supply services (National Action Committee 2005). However, field evidence has shown that despite the approach being widespread, it is not a panacea to sustainability due to high proportions of unsustainable water points reported in studies which have been done in the country (Hoko & Hertle 2006; Hoko et al. 2009; Dube 2012). The high proportions of unsustainable water points show that sustainability is still a problem despite the adoption of CBM. How the approach is being implemented in different contexts therefore needs to be investigated. With its well outlined principles, the CBM approach has the potential to improve sustainability in theory. However, inconsistencies in the interpretation and implementation of its principles may result in unexpected results being achieved. Where gaps and weaknesses exist between how CBM is supposed to be implemented and how it is actually being implemented provides a basis of planning for improvements. Lack of such knowledge may result in more services being implemented under CBM while no sustainability is achieved.

With the government investments in the rural water sector coming to a stand-still in the last one and a half decade in Zimbabwe, Non Governmental Organizations (NGOs) have become the sole investors in this sector. This has resulted in NGO strategies in the implementation and management of rural water supply systems gaining importance (Makoni & Smits 2007). With most NGOs including livelihood components in their projects (Machiwana 2010), the provision of communal water supply systems has been combined with productive uses such as gardening and livestock watering. The use of domestic water sources for productive uses is also part of the government's effort with support from NGOs to reduce malnutrition (Food and Nutrition Council 2010). Water sector organizations recognized that providing domestic water supply systems with livelihoods activities has multiple benefits which include promoting sustainability (Van Koppen et al. 2006). However, there is need to investigate how such strategies influence sustainability of water supply systems.

It is in this context that the study sought to explore the factors and CBM implementation practices influencing sustainability of water supply systems in Zimbabwe, and how these can be incorporated during different stages of development of a water supply project.

1.8 Objectives

- The aim of the study was to explore the factors and CBM implementation practices influencing sustainability of water supply services in Zimbabwe, and how they can be incorporated during different stages of development of a water supply project.

The study had the following specific objectives:

1. To determine the factors influencing sustainability of water supply systems in Zimbabwe.
2. To investigate how the implementation of CBM is contributing to the sustainability of water supply systems.
3. To explore how multiple uses of water influence sustainability of water supply systems under CBM.

4. To determine how the principal factors of sustainability and CBM implementation practices can be incorporated during the different stages of the development of a water supply project.

1.9 Research questions

The broad research question that guided this research is: Which are the factors and CBM implementation practices that affect sustainability of rural water supply systems in Zimbabwe, and how can they be incorporated during different stages of a water supply project? The specific research questions were:

1. Which are the factors that influence sustainability of rural water supply systems in Zimbabwe?
2. How is the implementation of CBM contributing towards the sustainability of water supply systems in Zimbabwe?
3. How do multiple uses of water influence the sustainability of water supply systems under CBM?
4. How can the principal factors of sustainability and the CBM implementation practices be incorporated during different stages of the development of a water supply project?

1.10 Significance of study

Literature on rural water supply indicates that a number of studies have been done to assess the sustainability of the rural water supply systems in rural areas of Zimbabwe (Hoko & Hertle 2006; Hoko et al. 2009; Dube 2012). These studies have been focusing on part of the factors that influence sustainability. Hoko et al. (2009) looked at reliability of systems, human capacity development, institutional capacity and cost recovery, while Dube (2012) only studied institutional issues focusing on water point user committees. Although these studies developed major insights into an understating of some of the factors that affect sustainability of water supply services, there is yet to be a grounded research that explores factors that influence sustainability in a holistic approach. Since sustainability is a complex issue, studying all factors that affect it is crucial (Montgomery et al. 2009). The establishment of the principal factors of sustainability will help in prioritising the factors that need immediate attention where resources will be limited.

Zimbabwe developed a framework that guides the implementation of CBM. Establishing the level of conformance by different stakeholders at different levels to the CBM guidelines will help to identify critical areas that need monitoring for sustainability to be achieved. Since the framework that is currently in use was published in 2005, any irrelevant sections as a result of policy changes will be identified so that improvements in CBM implementation will be suggested.

Studies on multiple uses of water have shown that productive uses such as gardening and livestock watering have impacts on livelihoods, wealth, income as well as health of communities (Flachs 2010; Chitongo & Magaya 2013; Lovell et al. 2014; Fielmua & Mwingyine 2015). However little is known on how multiple uses of water in this case gardening and livestock watering influence the sustainability of water supply systems. Such information is critical in formulating strategies that may promote the implementation or scaling up of livelihood activities that promote sustainability of water supply systems. Synthesising findings on key influencing factors and CBM implementation practices will be critical in informing policy formulation in the rural water sector of Zimbabwe. Policy formulation based on empirical findings may enable the implementation and management of sustainable water supply systems.

1.11 Definition of terms

Community: refers to a group of water users who live in the same area and have access to, and use the same water source.

Community participation: it is a process by which individuals, families or communities assume responsibility for local problems and develop a capacity to contribute to their own community development.

Community management: this is when a community takes a range of management tasks related to maintaining (and in some cases developing) water supply systems.

Community garden: a community garden is a piece of land fenced and cultivated by a group of people who share the same source of water, utilizing individual plots on public land.

Domestic water uses: refer to the consumptive uses such as drinking and cooking as well as hygiene uses which include washing, cleaning and bathing.

Improved water source: is one that by nature of its construction or through active intervention is protected from outside contamination, in particular from contamination with faecal matter.

Multiple water use: is an approach that seeks to plan, design, and manage water systems with the aim of meeting people's water needs for multiple purposes.

Productive water uses: these are the non-domestic uses such as livestock-watering and gardening that rely on water sources which were primarily intended for domestic uses.

Sustainability: a water system is sustainable if it is maintained in a condition that ensures reliable and adequate water supply, and benefits of the supply continue to be realized by all users.

Water supply system: refers to a potable water source which can be a borehole, deep well, shallow well, spring or sand abstraction site installed with a hand pump, windlass or rope and a bucket system.

1.12 Thesis outline

Chapter One (Background): is an introduction of the study, it gives a background and context to sustainability, multiple uses of water and community management in rural water supply. The chapter gives a brief description of developments in CBM in the water supply sector in Zimbabwe. It also outlines the problem statement and describes the objectives and research questions of the study. Justification of the study and definition of terms are also some of the key themes the chapter covers. Lastly the chapter gives the thesis outline and the chapter summary.

Chapter Two (Literature review and theoretical framework): the chapter is based on the literature review of the sustainability factors, the approaches used in the management of rural water supply systems and multiple uses of water. The discourse on sustainability factors covers financial, social, technical, environmental and institutional factors. Different case studies given in the chapter show how these factors influenced sustainability in different contexts. The chapter also discusses the approaches that are used to provide and manage water supply systems in rural settings. The approaches which are discussed include CBM, self-supply and Public Private Partnerships (PPPs). The impact of multiple uses of water on people's livelihoods, and the sustainability of water supply systems will also discussed. The productive uses of water that the chapter covers are gardening and livestock watering. The chapter concludes by discussing the theoretical framework that was adopted for analysis in the study.

Chapter Three (Methodology): gives a description of the study sites, their location and the main water sources used in the study area. The chapter also describes the research design and the sampling procedures used in the study. Reasons for selecting the applied research design and sampling techniques are also given. Data collection and analysis methods used in the study form the critical themes of the chapter. The justification on why the data collection and analysis methods were chosen, their utility and shortcomings, and challenges faced during data collection also form part of the chapter. The chapter also presents how the pilot study was done and how it helped in improving the main research design, data collection techniques and analysis. Positionality and reflexivity of the researcher and the methods used to improve the reliability and validity of the research findings are also discussed in the chapter. Lastly the chapter covers ethical issues which were considered in the study.

Chapter Four (Factors influencing sustainability of communally-managed water supply systems in Zimbabwe): the chapter is the first of the thesis' empirical chapters, and it presents results on factors and sub-factors of sustainability. It examines in detail the contextual differences on how factors impact on sustainability in the studied districts. The chapter also answers the question on the principal influential factors of sustainability.

Chapter Five (Implementation of Community Based Management (CBM) in Zimbabwe and its influence on sustainability): chapter five investigates how the CBM approach is being implemented by different stakeholders in the water sector. The focus of the chapter is on whether the approach is being implemented according to the CBM framework or not. The existence of relevant institutions, their practices and capacity in carrying out their expected duties will be discussed. The chapter will also cover the analysis on how the implementation of CBM is contributing towards sustainability of water supply systems.

Chapter Six (Influence of multiple uses of water on sustainability of water supply systems): the chapter explores how community gardening and livestock watering are influencing sustainability of water supply systems. The chapter covers the impact of multiple uses of water on financial, technical, social and institutional factors. A comparison on sustainability performance is done for water points used for domestic purposes only and those used for multiple uses. The chapter also shows how water points which are used for gardening have been performing during the pre-garden and during-garden periods.

Chapter Seven (Conclusions): The chapter synthesizes the key study findings and examines their implications on policy and practice. The chapter presents the proposed sustainability framework for the rural water sector of Zimbabwe which is based on key factors of sustainability and the best practices in CBM implementation. The framework aims to illustrate how the key factors of sustainability and the CBM implementation practices can be incorporated into different stages of a water supply project to enhance sustainability. The chapter also provides the key concluding statements of the study and practical recommendations based on the study findings.

1.13 Summary

The chapter gave the background on sustainability in the rural water sector. The disparities that exist between the developing and developed countries, and between the urban and rural areas show that rural communities in developing countries still suffer from inadequate water supplies. High figures of unsustainable water systems presented in different studies clearly indicate that sustainability is a challenge in most developing countries. Although participatory approaches have been adopted to solve the sustainability challenges, field evidence show that the approaches are not delivering as expected. This background led to the development of the research objectives and questions such that an understanding will be sought on the key factors influencing sustainability, how the implementation of CBM and multiple uses of water are influencing sustainability. The next chapter will present literature in line with the objectives of the study.

2 LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1 The discourse on sustainability factors

Some progress has been made in identifying factors that influence sustainability of rural water supply systems (Montgomery et al. 2009; Smits et al. 2013; Quin et al. 2011; Silva et al. 2012; Tadesse 2013; Spaling et al. 2014; Alexander et al. 2015). Studies have used different combinations of factors that can broadly be grouped into economic/ financial, social, institutional, technological and environmental factors. Some studies have also used different combinations of sub-factors of sustainability (Peter & Nkambule 2012).

Sustainability factors are important when assessing water supply systems since what may be considered sustainable in one context may not be the same for another setting (Lennartsson et al. 2009). However one key gap in the sustainability literature is the absence of a set of validated and consistent sustainability metrics to assess systems and allow for comparisons across studies (Alexander et al. 2015). For example some studies have used functionality of a system or water availability as a proxy for sustainability (Bamush & Krush 2006; Sarmuko & Yanja 2013). Alexander et al. (2015) argue that such measures have real limitations as a water facility may work improperly but still technically have water available (e.g. unsafe water collected at broken pipes). A standardized framework to assess sustainability will therefore contribute in overcoming such challenges in the water supply sector.

2.1.1 Social factors

A number of studies in the sustainability discourse have assessed water supply systems using social factors. Although social factors are considered to be important in influencing sustainability of rural water supply systems, there are no clear relationships of social factors and other sustainability factors. Community participation is one of the sub-factors under social factors besides conflict management, representation of men and women and participation of vulnerable groups in water projects. Literature has shown that a number of studies have attributed sustainability to community participation and a sense of ownership. In their study in Bolivia, Peru and Ghana, Whittington et al. (2008) concluded that the communities' lack of a sense of ownership was a contributory factor to low sustainability. In Ethiopia, Baye et al. (2012) also concluded that due to limited participation in planning and decision making at different stages of the project cycle, the water supply systems were not sustainable. They noted that professionals were deciding the type and level of facilities without active participation of the communities. Hoko et al. (2009) also concluded that the high number of unsustainable water points was due to a low sense of ownership in Zimbabwe. In Ghana, Doe & Khan (2004) concluded that a sense of ownership translated positively into community development which also showed high levels of sustainability. These results indicate that community participation creates a sense of ownership which affects sustainability of water supply systems. What is not always clear is how and at which stage of the project cycle community participation will contribute towards sustainability.

Studies have also shown that appropriate forms of community participation should be used for sustainability to be achieved. Marks et al. (2014) concluded that in Ghana sustainability was achieved where households participated in management related decisions and rather than where households participated in technical decisions only. Their conclusion contradicts the findings of Baye et al. (2012) that community participation in making technical decisions had a positive relationship with sustainability. A number of studies have also concluded that tokenistic participation should be avoided while effective participation at appropriate project stages should be promoted to achieve sustainability (Schouten et al. 2003; Harvey & Reed 2004; Marks & Davis 2012). Successful community participation that goes beyond mere consultation and includes a dialogue on technology options has been recommended for sustainability to be achieved (Katz & Sara 1997; UNDP 2011; U-Dominic et al. 2015).

Development practitioners have advocated for the representation of women and poor households in decision making for sustainability to be achieved (Fonjong et al. 2004; Ademiluyi & Odugbesan 2008; Aladuwaka & Momsen 2010). Although there is ample evidence to indicate that the active involvement of women contribute towards high project impacts and sustainability (Mukherjee & Van Wijk 2003; Aladuwaka & Momsen 2010), tokenistic involvement has been reported in some studies. Cleaver (1991) found out that while women were members of a hand pump water project committee in Zimbabwe, most of the tasks were performed by men. This means that the involvement of women was tokenistic which is sometimes done to meet donor requirements. No known studies have been done to show how the inclusion of the poor contribute towards sustainability.

2.1.2 Institutional factors

Institutional factors that influence sustainability include existence and functionality of user committees, provision of external support to user communities and training of user communities in CBM (Schouten et al. 2003; Whittington et al. 2009; WaterAid Tanzania 2009; Marks et al. 2014). Evidence has shown that setting up institutions at local level is a central factor in sustaining water supply systems. Such institutions should be established to provide ongoing financing and maintenance of the systems (Mugumya 2013). Katz & Sara (1997) concluded that the existence of institutions that maintain water supply systems affects sustainability. In their study, they showed that sustainability was significantly lower in communities that lacked such institutions. Harvey et al. (2002) also noted that sustainability was achieved where local institutions were in place to support communities in Ghana and Zambia. Although the existence of local institutions has been advocated for, some studies have shown that functionality and the capacity of such institutions is of great importance than their mere existence (WaterAid Tanzania 2009; Quin et al. 2011). This shows the importance of understanding how local institutions contribute towards sustainability as this will assist in identifying measures for enhancing their effectiveness.

Numerous studies have concluded that external support is another institutional sub-factor that influences sustainability of rural water supply systems (Schouten et al. 2003; Komives et al. 2008; Whittington et al. 2009). Although varying conclusions have been drawn on the nature of external support required, the most recurring forms of support include specialist technical and managerial assistance, capacity building in technical and financial management, conflict management, monitoring and motivation (Whittington et al. 2009; Marks & Davis 2012). Other studies have also shown that the external support required by rural communities is context specific as communities' social capital tends to vary (Gleitsmann et al. 2007). Where communities are expected to manage their own water supply systems, studies have shown that it is unrealistic to expect such communities to cope with all major/complicated technical problems and conflicts that may arise (Harvey & Reed 2004; Marks et al. 2014). Whittington et al. (2009)

supported this when they noted that communities should not be conceptualized as an island, hence the role of external support should not be neglected in water supply service delivery. Leaving rural communities to manage water supply systems on their own, therefore, may contribute to unsustainable services as some challenges may exceed their ability to maintain the systems.

A number of studies have also shown that institutions should be capacitated for sustainability to be achieved (Lammerink 1998; Lockwood 2002; Mtisi & Nicol 2003; Quin et al. 2011; Moyo 2013). It has been noted that capacity building should be at both community and district levels (Lockwood 2002; Lockwood 2004; Giné & Pérez Foguet 2008). User committees/communities need to be trained in operations and maintenance especially where the CBM approach is used (Harvey & Reed 2007; Moriarty et al. 2013). Hoko et al. (2009) found out that, communities in the Mt Darwin District of Zimbabwe were not adequately trained in operation and maintenance leading to high rates of non-functional water points. Danert & Flowers (2012) also noted that inadequate training of user committees negatively influenced sustainability.

Poor coordination between different stakeholders and institutions in the water sector has also been identified to have a negative influence on the sustainability of water supply systems. Harvey et al. (2002) showed that lack of co-ordination between provincial and local government institutions and NGOs led to overlaps, conflicts and omissions in service delivery in Zambia. This shows that there was a need for clear lines of responsibilities and authority for different stakeholders in the water sector for sustainability to be achieved.

2.1.3 Economic factors

The economic factors that influence sustainability include the establishment of an O&M fund, regularity of making financial contributions by water users, adequacy and transparency in managing O&M funds contributed by water users, and rules on making financial contributions. The establishment of an O&M fund was found to be critical for the sustainability of water supply systems (Peter & Nkambule 2012; Ihuah & Kakula 2014). Peter & Nkambule 2012 concluded that setting an O&M fund was one of the most important financial factors that influenced sustainability in Swaziland. An evaluation of water supply projects in Nigeria also indicated that community managed projects failed due to the absence of an O&M fund at community level (Ihuah & Kakula 2014). Haysom (2006) also concluded that the absence of an O&M fund was the principal cause of non-functional water points in Tanzania. Resources from the fund are of importance for financing O&M costs of the water systems. Despite evidence from these studies that the establishment of an O&M fund at community level influences sustainability, some scholars have argued that this is an unfair practice as it is a burden on poor rural communities (Sachs 2005; Baumann & Danert 2008). Given that in rural areas some households only receive income at harvest (Sachs 2005; ZimVAC 2013), other financing mechanisms should be developed for sustainability to be achieved.

Transparency in the use of O&M funds is another financial factor that influences sustainability of water supply systems. Hoko et al. (2009) showed that, user communities in Mt Darwin District of Zimbabwe were unwilling to pay money in advance to WPCs because they feared that the money would be misused. This negatively affected sustainability since money for O&M was collected after a breakdown which prolonged the downtime period. Under such circumstances Dube (2012) suggested that it would be necessary to institute professional and trustworthy structures. Training of user committees in financial management may also be a solution where transparency is a challenge in the management of water supply systems. Harvey & Reed (2004) showed that, usually funds that are collected for O&M are inadequate. Baumann & Danert (2008) in Malawi and Dube (2012) in Gwanda District of Zimbabwe concluded that communities were unable to contribute adequate funds due to high poverty levels. However, Hoko et al. (2009) blamed the absence of rules on making financial contributions within communities to be exacerbating the collection of inadequate O&M funds. This shows the need to set up and enforce rules on fee collection for users to be obligated to make financial contributions. In turn, this may result in the collection of adequate funds when the funds will be needed.

2.1.4 Technical factors

Studies have shown that although technology alone does not determine sustainability, it has a major impact on ongoing O&M (Machiwana 2010; Adams 2013; U-Dominic et al. 2015). Technological factors found to influence sustainability are the choice of the technology of the water supply system, the availability and affordability of spare parts. Inappropriate technologies have been associated with poor levels of maintenance leading to low sustainability of water supply systems (Harvey & Reed 2007; Tadesse 2013). U-Dominic et al. (2015) concluded that inappropriate engagement of communities in water supply programs resulted in the implementation of inappropriate technologies in Nigeria. This had a negative impact on the maintenance of the water supply systems. Research has shown that technology options which are low-cost, easy to understand and maintain are likely to be more sustainable than those that require specialist skills and equipment (Haysom 2006; Adams 2013; Machiwana 2010).

It has also been noted that even with appropriate technologies there should be sustainable spare parts supply for sustainability of water supply systems to be achieved (Oyo 2002; Harvey 2011). Ihuah & Kakula (2014) in their study observed that lack of spare parts had a negative influence on O&M of water supply systems. Spare parts supply chains have been noted to be critical especially in Africa where most hand pumps are imported (Harvey & Reed 2004). Where spare parts would have been availed, Baumann & Danert (2008) noted that the purchase of the spare parts should be made economically feasible and viable. Quality specifications should also be put in place and spare parts should be available at community level for sustainability to be promoted.

2.1.5 Environmental factors

Studies that have incorporated environmental factors in assessing sustainability are not common. According to the sustainability literature, environmental factors that are used to assess sustainability are availability and adequacy of water supply, water quality at source and potential for contamination (Peter & Nkambule 2012; Spaling et al. 2014). For comparative reasons these environmental factors will be used in this study. In terms of water quality, Hoko et al. (2009) noted that boreholes which were perceived to be having a salty taste were not maintained. In their findings they noted that in such cases users opted for water from sand abstraction sites as this was perceived to be better despite the health risks associated with the water sources. Spaling et al. (2014) concluded that changes in rainfall patterns reduced recharge and increased water demand which negatively influenced sustainability of water sources in Kenya. On the other hand in Swaziland, Peter & Nkambule (2012) could not establish a clear relationship between sustainability and potential of contamination. This shows a need for an understanding on how potential of contamination as an environmental factor contribute towards sustainability of water supply systems.

From the literature it can be gleaned that the key issues underpinning sustainability are financial/ economic, environmental, technical, social and institutional. Therefore, when assessing sustainability it is important to be clear from the onset on what is and what is not meant by sustainability in a given context.

2.2 Supply and management approaches used in the rural water sector

Water supply management is pivotal to ensure the provision of sufficient amount of water and of good quality to communities. A number of participatory supply and management approaches have been adopted in the quest to improve sustainability. The common approaches adopted are the Demand Responsive Approach (DRA), CBM, Self supply and management, and Public Private Partnerships (PPPs) (Black 1998; Quin et al. 2011). The following sections will present detailed discussions on these approaches.

2.2.1 Demand Responsive Approach (DRA)

The Demand-Responsive Approach (DRA) which is also known as the Demand-Driven Approach (DDA) in the rural water supply literature was a responsive approach to the negative results obtained by the Supply Driven Approach (SDA) where governments provided services (Katz & Sara 1997; Black 1998; Parry-Jones et al. 2001). The DRA was championed by the World Bank with an intention to complement CBM. Deeply rooted in the neoliberal theory, the approach aimed to ensure that the type of water supply provided was appropriate to the demand made by user communities (Quin et al. 2011; Mugumya 2013). The demand in this context is in the sense of economic demand or expressed as the willingness to pay for O&M which is shown by the ability of the communities to contribute part of the capital cost.

The capital cost that is contributed by user communities is five percent of the total costs of the facility in most African countries, and it can be up to 50% in Asian countries (Fonseca & Njiru 2003). Financial contributions towards capital costs have been seen as a proxy for the willingness to pay for the operation and repair costs of water supply systems (Katz & Sara 1997; Quin et al. 2011). However, this has been contested since in some cases the contributions are done by individual politicians and not the relevant households. Harvey & Reed (2004) noted that such a means of assessing demand does not necessarily ensure that the community will contribute funds for O&M. Furthermore, it has been noted that poor households may not have the means to express demand (Cleaver & Toner 2006) if it is based on financial contributions of capital costs, thus giving a wrong picture in terms of what the communities will be demanding.

Fonseca & Njiru (2003) argued that there is no consensus on whether users should pay for capital costs or not under the DRA. If so, this raises questions such as what percentage should the communities pay, how it should be paid, and to what extent should costs be recovered. Moriarty et al. (2013) could not rule out the link between low capital contributions and poorly performing tariff collection systems. However, they could not get the evidence that increasing the initial capital contribution would lead to better cost recovery from households. This shows a need for an investigation of how different financing mechanisms contribute towards sustainability such that effective payment mechanisms can be established in the rural water sector.

Katz & Sara (1997) concluded that sustainability was high in communities where DRA was employed in Uganda, Benin, Honduras, Indonesia, Pakistan and Bolivia. The demand for water supply services was in terms of selection of a project and the technology preferences by user communities. Technological choices by user communities were also found to be critical in influencing sustainability in Nigeria (U-Dominic et al. 2015). However, literature has shown that inconsistencies in applying the approach in different communities may hinder sustainability.

Katz & Sara (1997) observed that the inconsistencies occur when project employees sometimes use the supply driven approach instead of the DRA.

2.2.2 Community Based Management (CBM) approach

The theoretical frameworks that underpin community management have been identified to be the neoliberal perceptions on reduced state involvement, people first, equity and empowerment approaches (Asthana 2003; IRC 2004). However, Harvey & Reed (2004) contested that these frameworks only contributed to the prevalence of community management. In their argument, they indicated that the frameworks are secondary to poor service delivery and performance by government institutions, the suitability of community management to the project approaches adopted by NGOs and donors as well as the hegemonic nature of development.

Due to poor service delivery and performance by government institutions, community management resulted in many governments decentralising the delivery and maintenance of rural water supply services to communities (Asthana 2003). Several scholars have argued that high levels of poverty in most rural areas in developing countries may be a prohibiting factor for communities to contribute towards O&M (Lockwood 2004; Opare 2011; Dube 2012). Where communities rely on agriculture, the communities only receive income after a harvest which has detrimental effects on the establishment of an O&M fund (Sachs 2005). Therefore, in such cases, sustainability of water supply systems will be questionable as financial factors will be compromised. Regular contributions towards O&M have been associated with rapid repairs and reduced downtimes of water supply facilities showing their importance for sustainability.

Evidence has shown that, when using the CBM approach communities should not be expected to overcome all complex challenges on their own (Jiménez & Pérez-Foguet 2010; Whittington et al. 2009). Government departments, NGOs and the private sector are supposed to continually provide necessary external support (Bakalian & Wakeman 2009). This is however, against the ideology of limited external support to communities when using the CBM approach. A number of studies have indicated the importance of external support from governments for the sustainability of water supply systems to be achieved (Komives et al. 2008; Bakalian & Wakeman 2009; Jiménez & Pérez-Foguet 2010).

The project approaches adopted by NGOs and donors have also embraced the CBM approach. According to Harvey & Reed (2004) donors and NGOs by mobilizing and sensitizing communities about projects, this gave these organizations a clear conscience to hand over the projects to communities for their management at the end of the project's life. Without adequate capacity building, sustainability of water supply systems may be negatively affected. As cited by Giné & Pérez Foguet (2008) it is much easier, faster and controllable to construct schemes than it is to build up the recipients capacity to maintain them. This is why the approach is now being known and referred to as 'built-and-forget approach" (U-Dominic et al. 2015). Harvey & Reed (2007) concluded that for sustainability to be achieved under CBM, donors should not do business as usual, by simply targeting to install new facilities over a certain period of time. Instead, installation of facilities should be coupled with formation and training of local level management structures. Such structures will be of importance in monitoring and maintaining the water infrastructures when the NGO projects come to an end. However, the success of such investments will then depend on the capacity of the government departments to monitor and offer external support to the local community structures. Notably the capacity of the governments departments has been found to be generally low in most developing countries resulting in low sustainability (Cleaver 1991; Schouten et al. 2003).

Communities in low-income countries have often been viewed to be homogeneous by the western world which is not always true (Harvey & Reed 2004). This view has often proved to be a myth and it is based on cultural idealization of rural communities (Rural Water Supply Network 2010). There is need for realism than idealism when working with rural communities considering the power and cultural dynamics that exist (Harvey & Reed 2007). Marks et al. (2014) concluded that, there was no homogeneity in ownership of community managed projects across the communities which they studied in Kenya. This result supports the view that communities in low-income countries are not homogeneous, hence the differences which exist between them should not be ignored.

One of the assumptions of CBM that has always been questioned in literature is that a sense of ownership improves sustainability. Cleaver (1991) in Zimbabwe found out that, a sense of ownership improved sustainability of water supply projects. Findings by Haq (2014) also showed that sustainability of water supply systems was significantly related to community ownership in Pakistan. However, there may be need to know the extent to which a sense of ownership influences the sustainability of water supply systems. Schouten et al. (2003) noted that in such cases individual ownership supersedes communal ownership. Schouten and Moriarty concluded that, a sense of ownership was higher in small communities than in large communities in Ghana. This resulted in the small communities managing their water supply systems in a sustainable manner than the larger communities. However, Harvey & Reed (2004) contested that there is no automatic relationship between a sense of ownership, willingness to manage, and the sustainability of water supply systems. Although communities may express a sense of ownership, sustainability in the same communities may not be achieved. This shows the importance of understanding factors that influence sustainability of water supply systems in different contexts.

Despite the weaknesses that CBM has demonstrated in sustaining water supply systems the approach has undoubtedly brought many benefits (Lockwood et al. 2003). Field evidence has shown that CBM has indeed improved the performance of water supply systems in some cases (Meinzen-Dick & Zwarteveen 1998; Mathew 2005; Oldfield 2007). However, scholars have advocated for other approaches such as self-management and private public partnerships to be considered for sustainability to be achieved. According to Butterworth et al. (2013) the proposed approaches should not replace CBM, however they have to complement CBM where it will be failing.

Professionalization of CBM where some water services will be provided through PPPs and provision of services is paid for, is another suggestion that has been put forward by scholars (Lockwood & Le Gouais 2011; Moriarty et al. 2013). Moriarty et al. (2013) argued that CBM has to be professionalized not principally because the approach has failed, but because it is reaching the limits of what can be achieved in an approach based on informality and voluntarism. Rising standards of living and education are leading to an inexorable rise in expectations of rural water users, wanting (even where they cannot or are not willing to afford) more than the very basic levels of service provided under community management (Moriarty et al. 2013). At the same time, these trends reduce community cohesion and volunteerism that form an underlying assumption behind community management. Therefore, professionalizing CBM may enhance sustainability.

The foregoing discussion possibly explains why CBM is failing to improve sustainability of rural water supply services despite its participatory nature and widespread use (Quin et al. 2011). This brings about the question whether involving user communities in the management of their water supply systems is a solution to sustainability, or it is just a responsibility shift from government to user communities to provide and maintain water supply systems? To fulfil the right to water and maintain the gains of the sustainable development goals under CBM the question will be, which strategies can be adopted to enhance sustainability?

2.2.3 Self-supply and management approach

Self-supply is when individual households (or sometimes even a group of neighbours) invest in improving their own water services (Sutton et al. 2004). Under the approach the O&M of the water systems is also done by the households themselves. The approach builds on the widespread desire of communities to invest in solutions that benefit their individual households or small groups directly rather than as members of larger communities (Lockwood & Smits 2011). Historically and even today the approach has been very important in filling in the gap where public or private sector approaches do not reach (Lockwood 2004). Such places have been identified to be mainly scattered rural homes, informal settlements and peri-urban areas. However, self-supply has also been a preferred water supply approach in urban areas where supply of the service by local authorities is intermittent and is of poor quality (Nyatsanza 2013). Makwara & Tavuyanago (2012) noted the prevalence of the approach in most urban centres of Zimbabwe due to poor service delivery by the responsible authorities. The non-availability of council water in urban areas such as Harare for long periods due to obsolete water plants has resulted in residents using self-supply facilities such as wells and boreholes as coping mechanisms.

Self-supply has a number of advantages over the community management approach. The main advantage of the approach is that household-owned systems tend to be better maintained than communal systems (Lockwood 2004). Literature has proven this using sector statistics of Zimbabwe where the non-functionality rate of facilities which were individually owned and managed was 12% as compared to 30% of communally managed systems in 2004 (Water and Sanitation Program 2004). A follow up study which was done in 2006, showed consistent results where 88% of private family wells were working against 72% of communal deep wells and boreholes in Zimbabwe (Water and Sanitation Program 2006). The same trend was also found in the year 2001 in Kaoma District of Zambia, where 94% family wells were functioning against 49% communal wells (Water and Sanitation Program 2004). These differences could be explained by the fact that households are more likely to maintain water systems that they legally own and which do not require relatively complex CBM arrangements (Moriarty et al. 2013). The financial investments done by households and groups instil a strong sense of ownership of the facilities resulting in willingness to maintain hence the overall sustainability of the facilities.

The other advantage of self-supply systems is that low cost technologies are mostly used under the approach. This has resulted in poor rural communities being able to supply their own water. In areas with high water tables, households have been digging their own lined wells and installing rope and bucket, windlass and rope and washer technologies. These technologies have been found to be locally available and affordable in many rural communities (Guzha et al. 2007). For example, in the remote rural areas of Zambia, the government's per capita costs for the most expensive phase for self-supply were found to be between 25-33% of the cost for community services (Water and Sanitation Program 2004). Danert & Sutton (2010) observed that the self-supply approach reduced government costs on rural water supply by 85% compared with community water systems in Uganda. In addition, the cost of maintaining self-supply systems is lower as compared to that of communally-managed systems (Sutton 2011). This approach can therefore help in bridging the funding gap for rural water supply that exists in many developing countries.

Katsi et al. (2007) concluded that, households with upgraded family wells were practising gardening which could not be done by those using communal water points in Marondera, Uzumba and Murehwa districts of Zimbabwe. The self-supply approach promotes multiple uses of water at household level than community managed approaches. The presence of rules at communal water points and the scarcity of water during the dry season are the major prohibitive factors for households using communal water points to engage in multiple uses such as gardening (Guzha et al. 2007). On the other hand Smits et al. (2010) and Van Koppen et al. (2006) blamed the sectoral approach used in the provision of water services (see Section 2.3).

Water systems under self-supply are often located within the homesteads or a few meters away from the homestead. This reduces the distance that women and children walk to collect water for the household. Literature has shown the impacts of long distances on women's and children's health, security and work load (Aladuwaka & Momsen 2010). Hence the benefits brought about by self-supply services should not be underestimated.

Despite the advantages of the self-supply approach discussed in literature, it is of great concern that to date the approach has not been supported by many governments (Butterworth et al. 2013). Little has been done to incorporate the approach into national rural water policies and strategies as its relative importance to the sector is not fully understood nor appreciated (Lockwood & Smits 2011). However, countries that have promoted the approach through policy and water supply strategies have managed to accelerate water access within rural communities. This was evident in Zimbabwe during the early 1990's when government and donor programmes supported the protection and upgrading of shallow family wells which resulted in over 120,000 wells being up-graded. These wells served more than 1.5 million people at minimal subsidy by donors or the government of US$3-5 per capita (Sutton et al. 2004).

In the self-supply approach, households are the key actors in the provision and management of facilities. However, an enabling environment is of great importance to encourage a wider uptake, better performance and safe use of facilities under the approach. According to Sutton (2011) this enabling environment has been termed Self-supply Acceleration in the water supply literature. The enablement can be through technical advice where households have to choose technologies depending on individual affordability. Enablement can also be through policies developed by the government or support agencies (Sutton et al. 2004). Where enabling policies exist the self-supply approach has been found to be bringing additional benefits that are in line with wider government objectives. An example was given by Butterworth et al. (2013) where self-supply as part of government policy supported small-scale irrigation in Ethiopia.

2.2.4 Public Private Partnership (PPP) approach

The water supply sector has been undergoing a series of reforms in an attempt to deliver improved services. The reforms that include the adoption of PPPs have been mainly influenced by international actors particularly the World Bank and other bilateral agencies. The ADB (2008) handbook notes that the term "PPP" describes a range of possible relationships among public and private entities in the context of infrastructure and other services. Numerous definitions of PPP have been given in literature and the definition that will be used in this study is by the (ADB 2008) which states that, "Public–Private Partnerships are cooperative ventures between a public entity and a private party, aiming to realize common projects in which they share risks, costs and profits". This entails government releasing its stake in a publicly owned institution or company, either partially or in full, to the private sector. Of great significance to note is that these partnerships do not only benefit the government, instead they are supposed to create a win-win situation or mutual benefit by capitalizing on the strong points of each partner (Jamali 2007). In this regard the question that may be raised is how can the human right to water be protected under PPP arrangements? Fears are that, consumers may be exploited while partners aim to maximize their benefits in the water sector.

PPPs are a relatively recent phenomenon for management of water supply in rural areas although they have been in existence for many decades in other sectors. The shift towards PPPs in the water sector started in the 1990s and various reasons have been put forward for their use in the sector. Despite the various arguments for PPPs, there seems to be a common thread in the reasons for their adoption (Jamali 2007). The common thread is the desire to improve water supply services due to the failure of public sector management and community based management (Carter 1998; Lockwood 2004; Moriarty et al. 2013). Lockwood & Le Gouais (2011) highlighted that, given the emerging complex water supply needs and high demands for service levels, PPPs have become unavoidable and indeed desirable in many countries. The complex water needs have been noted to be as a result of population growth, increased number of larger rural communities and growth centres (Moriarty et al. 2013). In support of this, Lockwood & Le Gouais (2011) argued that these contexts are well beyond the scope of conventional CBM arrangements suitable for small, low-density rural villages hence the need for a change in management arrangements. Replacing conventional CBM with PPPs is supposed to professionalize CBM where some of the responsibilities in water supply will be left with Community Based Organizations (CBOs) while others are out-sourced from private service providers.

The World Bank and the International Monetary Fund advocated the use of PPPs in the water sector based on the assumption that private entities improve management as they invest capital in order to improve infrastructure, and system performance, reduce water tariffs and are more responsive to consumer needs (Prasad 2006). Burger et al. (2009) argued that, most government owned enterprises in developing countries run huge budget deficits which result in failure to deliver services as expected. On the other hand where water supply systems will be under CBM, poor financial performance by WPCs has been noted resulting in inefficient and ineffective local institutions (Schouten et al. 2003; Quin et al. 2011). Under such cases, arguments to involve the private sector have been justified while reserving the role of regulator for the government. PPPs are assumed to bring about service efficiency gains. The efficiency gains are achieved through improvements in billing and collection of user fees since private operators are considered to be more proactive and responsive than their public counterparts. In support of this (Annis & Razafinjato 2011) noted that PPPs allow economies of scale by delegating management contracts to large geographical areas.

Another argument for PPPs is that they enable the government to meet a wider range of policy objectives and align risks and responsibilities between the public and private sectors (Hodge & Greve 2009). This is possible since the separation of functions makes it relatively easier for the government to hold the private operator accountable. This also helps to improve the quality of service received by the consumers where policies are properly implemented (Kleemeier 2000). Annis & Razafinjato (2011) argued that PPPs result in more autonomy for service providers.

Despite the potential that PPPs have in improving sustainability of service provision in the water sector some authors have criticized the approach (Wettenhall 2003; Hall & Lobina 2007; Van Dijk 2008). The opponents of PPPs regard this as a neo-liberal solution leading to water being sold. Van Dijk (2008) contested that the approach makes water to be expensive and results in tariff increases in the form of cost recovery. Hall & Lobina (2007) also argue against PPPs stating that the profit motive of the private sector marginalize the poor. The argument here is that, even though water has to be paid for through cost recovery principles, poor households may not afford the costs (Bakker 2008). This may result in higher costs for the poor, while private operators enjoy greater profits. The opponents therefore call for a strong regulatory framework for PPPs (Hall & Lobina 2007). Independent regulators have been preferred to protect the interests of the society at large (Wettenhall 2003). Water sector specific regulatory frameworks which see to it that the private sector respects the rules formulated, have also been advocated.

Various types /models of PPP are used in the management of water supply. These include performance based service contracts, management contracts, affermages/ lease contracts and long-term contracts. The selection of these PPPs depends on the duration of a service required from the private operator as well as the nature of the required service. These PPPs are discussed in the following sections.

i) Performance based service contracts

Performance based service contracts refer to arrangements whereby the public authority retains responsibility for operation and maintenance of the system and contract out specific activities of the system to the private sector for a fee. It may involve a private operator focusing on commercial and financial management and the performance has to be according to the agreed cost and must typically meet the performance standards set by the public sector (Van Dijk 2008). This means that the contractor’s profit increases if it can reduce its operational costs while meeting required service standards. Service contracts usually have a duration of six months to two years.

Performance based service contracts are usually most suitable where the service can be clearly defined in the contract, the level of demand is reasonably certain and performance can be monitored easily (AfDB 2013). They have the advantage of providing a relatively low-risk option, a quick and substantial impact on system operations and efficiency and a vehicle for technology transfer and development of managerial capacity. If designed correctly, they can assist in ensuring that service improvements reach marginalized and poorer communities. Reduced revenues in poorer areas contribute to private sector reluctance to expand into these areas. However, performance based service contracts can overcome this by building in financial incentives to ensure that services are delivered more equitably across all income groups (Prasad 2006). Nevertheless, this type of PPP has been challenged for hitting the target but missing the goal. This happens when selected indicators are not a true measure of the desired performance standard. Performance based contracts are also contested since political vulnerability may be experienced considering that the public sector remains in charge of tariff setting and assets making it difficult to sustain the system (AfDB 2013). This type of partnership is also not suitable if the main objective is to attract capital investment.

ii) Management contracts

This type of PPPs is considered as a first step towards implementation of long-term PPPs. In these arrangements, the ownership and asset management remains with the public authority while the private sector brings in specific expertise to increase efficiency, enhance management structures and build capacity (Prasad 2006). Although the ultimate obligation for service provision remains in the public sector, daily management control and authority is assigned to the private partner operator. The contracts usually have a short duration of 3-5 years and sometimes they are used as a stimulus for change and open the door to new approaches. The advantage of the management contract is that of operational gains that result from the private sector management without actually transferring assets to the private sector. Management contracts are also less difficult to develop, less controversial and less costly in terms of fewer staff from the private sector being part of the arrangement. In light of this they may be favoured by private sector financiers as less risky in the face of economic uncertainty, political instability and currency devaluations.

Despite the advantages discussed in the paragraph above management contracts have their own disadvantages. One of the disadvantages is the split between the obligation of services and management on one hand, and the financing of expansion planning on the other hand. This could inhibit the private sector from enjoying the autonomy or the authority thus not being able to make meaningful change (Burger et al. 2009). Again Koestler (2009) noted that being paid a portion of profits may encourage the private sector to inflate the reported achievement or deficit maintenance of the system to increase profits. Since these contracts are for a period between 3-5 years and are often structured to bring about rapid changes and "quick wins" they have tended to focus on easier reforms, such as information systems or billing systems. The contracts also fail to include substantial institutional reforms such as management restructuring, staff training or long-term investment planning which are often required to support the long-term sustainability of utilities. Of great importance again is whether any improvements brought about by the contract will be sustained once public management returns.

iii) Affermages (Lease) Contracts

Under the affermage (lease) model, the lessee (private operator) 'rents' the facility from the public authority and becomes responsible for operating and maintaining the system. The operator provides the service at his expense and risk while new replacements and investment remain the responsibility of the public authority. The duration of the contract is usually between 8-15 years. The private operator pays a fee for the use of the assets and the risk involved is considered to be medium. The advantage of the affermage contracts is that this provides incentives for the operator to achieve higher levels of efficiency and higher sales (AfDB 2013). However the model reduces government's investment in other sectors of the economy since no private sector investment is mobilized. Furthermore tariff adjustment can be very sensitive and complex considering that the contractor derives the payments from the revenue collected from customers (Hall & Lobina 2007).

iv) Long-term concessions

In the concession arrangement the concessionaire (private operator) has the overall responsibility for services, including operation and maintenance of assets. The private operator is also responsible for capital investments during the concession period, carrying all commercial risks for construction of fixed assets, operating and maintaining those assets in exchange for tariffs that they will be collecting. Ownership of the fixed assets remains with the public authority. The duration is usually between 20-30 years to ensure a reasonable return to the concessionaire on the capital invested in new works. Concessions can take a form of what is known as the Build Operate Own and Transfer (BOOT) or Build Operate and Transfer (BOT) projects (Haarmeyer 1997). BOOT contracts are generally used to construct new systems or parts of the systems and the private operator assumes responsibility for operation and maintenance in exchange for a fee. Under such arrangements the user pays directly to the operator. After a predetermined time, the facility is transferred back to the public authority.

The strength of concessions lies in their ability to attract private finance required to fund new construction or rehabilitating existing facilities. Again the concession arrangement provides incentives to the operator to achieve improved levels of efficiency and effectiveness considering that gains in efficiency translates into increased profits and returns to the private operator. However concessions may be politically controversial and difficult to organize (ADB 2008).

This shows that in the PPP landscape water supply services may be improved. However, strong regulatory frameworks are the backbone of the protection of consumer interests. Therefore the motivation of the public sector should not only lie with the need for improved investment, while for the private sector it is the need for the profits, instead the strengths of each sector should motivate such partnerships for the benefit of water users.

2.3 Impacts of multiple uses of water on sustainability of water supply systems

Poverty reduction has globally remained central in the development agenda of donors, governments and civil society organizations (Fielmua & Mwingyine 2015). Since most poor regions and households lack access to adequate water, most poverty reduction strategies include water infrastructure development (Hanjra & Qureshi 2010). In regions such as South Asia and sub-Saharan Africa with high levels of poverty, water provision should take a strategic approach, by considering multiple uses of water (van Koppen et al. 2014; Faal et al. 2008). However, the emphasis has been on the provision of potable water since the 1980's. Studies have shown that where water infrastructure is installed for domestic purposes, policy makers and operational staff of water agencies discourage multiple uses of water (Smits et al. 2010b). Ignoring the multiple uses of water and turning a blind eye on the practice has resulted in communities misusing water supply systems as they address their productive needs. This has been found to have adverse effects on the sustainability of water systems as well as livelihoods of the rural poor (IRC 2004).

Several studies have shown the benefits of multiple uses of water at both household and regional levels (Cousins et al. 2006; Katsi et al. 2007; Smits et al. 2010b; Fielmua & Mwingyine 2015). At the regional level, Faures et al. (2008) in Fielmua & Mwingyine (2015) argue that upgrading or installing systems to accommodate multiple uses of water can benefit 52% of the sub-Sahara African population. It is against this reality that multiple uses of water have to be planned for and taken seriously by development practitioners in order to diversify livelihoods within poor communities. Planning for multiple uses of water has been found to have a positive influence on the sustainability of water supply systems. Smits et al. (2010b) noted that where multiple uses of water are not planned for and recognized, communities are forced to have informal access to water through unauthorized connections or exceeding capacity of the system. This was found to have a negative impact on the functionality of systems due to frequent breakdowns and conflicts among water users (Schouten et al. 2003). These challenges are likely to be solved by planning for and authorizing multiple uses of water.

Using water supply systems for multiple uses has resulted in increased income through crop and livestock production at household level (Guzha et al. 2007; Fielmua & Mwingyine 2015). In

Nepal households had their income increased by 10% through multiple uses of water (Mikhail 2010). Studies by Katsi et al. (2007) in Zimbabwe, and Smits et al. (2010a) in Honduras, showed an increase in household income through using domestic water supply systems for multiple uses. Although multiple uses of water have been found not be the seldom income source for households this diversifies and enhances income sources (Galhena et al. 2013). Since communities will be having these diversifications through water use this motivates them to maintain the water systems (Bolding et al. 2011). Van Koppen et al. (2009) also noted that where domestic water systems are shifted to multiple water uses that meet one's water needs, the ability and willingness to pay for water services is improved. Where this can be harnessed this may attain full cost recovery which is encouraged under CBM for sustainability of water systems to be achieved (Schouten et al. 2003). However, in order for multiple uses of water to act as a motivator of maintaining water systems this depends on the relative extent and significance of productive activities being carried out (Smits et al. 2010a).

Several scholars argue that where water supply systems incorporate multiple uses, there are prospects of sustainability due to the use of cost effective water supply technologies (Smits et al. 2008; Srinivasan et al. 2012; van Koppen et al. 2014). These technologies such as rope and washer pumps (Katsi et al. 2007) were found to be appropriate for multiple uses of water in some parts of Zimbabwe. The advantage of such technologies is that they may be constructed and maintained using local resources which may reduce the financial burden on water users in poor communities. The reduced financial burden on O&M has the potential to contribute towards sustainability as the technologies may be repaired by local people using locally available material at a low cost.

Despite the opportunities that multiple uses of water have, literature has revealed some threats that the practice has on sustainability (Slaymaker et al. 2007; Kanyoka et al. 2008). Water supply systems are at high risk of frequent breakdowns where development practitioners ignore the reality of multiple water needs and do not plan for them (Faal et al. 2008). Not having formal access to sufficient water for production results in illegal connections to water supply systems (IRC 2004). Illegal connections have been associated with overexploitation of water resources and high chances of contamination where water points will be providing water for livestock drinking (Srinivasan et al. 2012).

Conversely, where multiple uses of water would have been planned for, a number of sustainability threats also exist. Smits et al. (2010a) noted that in Honduras although multiple uses of water were planned for, sustainability was compromised due to conflicts by communities in Quebradits, Manzaraguao and Paso Alianza areas. It was reported that these conflicts were mainly due to inequitable water distribution and over use during certain periods of the year. Concerns over equity in access between large and small water users are also a source of potential conflicts in multiple water uses (Smits et al. 2008). These results show strong evidence of the need for additional management measures which may be required to ensure sustainability under multiple water systems especially where communities will be having diverse user categories as well as water use priorities.

Although the practice of multiple uses of water has been applauded by development practitioners for increasing and diversifying communities' income (Cousins et al. 2006; Van Koppen et al. 2006; Mikhail 2010) this has not always been the case. Instead Smits et al. (2010) in Honduras found out that systems serving multiple uses of water faced financial challenges. Multiple uses of water did not automatically result in financial sustainability. Lack of financial resources for O&M has adverse effects on the sustainability of water systems (Harvey & Reed 2007; Whittington et al. 2009). This shows a need to understand how communities practicing multiple uses of water may be made to appreciate the need to make financial contributions for the O&M of their water systems for sustainability to be enhanced.

2.4 Theoretical framework

The impetus of the World Commission on Environment and Development (Brundtland 1987) on the term sustainable development significantly influenced the development agenda since the 1980s. With livelihoods becoming a focal point of development for practitioners and researchers in the 1990s, the term Sustainable Livelihoods (SL) became popular in the development discourse. SL has been seen as a way of thinking about development in particular rural development, which calls for integrative thinking for poverty reduction (Farrington et al. 1999). Although the term 'Sustainable Livelihoods' has been used widely in poverty and rural development research, there is no broadly accepted definition of the concept. As a result different governments, organizations and individuals implementing sustainable development interventions have adopted their own understandings of the term (Chambers & Conway 1991; Ellis 2000; Hussein 2002).

Despite numerous definitions provided in the sustainable livelihoods literature, the work of Chambers & Conway (1991) was considered fundamental, and led to a number of governments employing SL approaches in rural development (Carney et al. 1999). Scoones (1998) referred to the work of Chambers and Conway as a seminal effort towards SL due to its profound influence on contemporary SL work. Chambers & Conway (1991) defined SL as a livelihood that comprises the capabilities, assets (including both material and social resources) and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets, while not undermining the natural resource base (Chambers & Conway 1991). In their definition, the importance of capabilities is accentuated. They heightened that, livelihoods abilities should be both on performance and recovering from the potential shocks and stresses which they consider are key features of sustainability.

Frameworks that have been developed for the analysis of SL are the Bebbington's Capitals and Capabilities Framework and the Sustainable Livelihoods Framework (SLF). Although these frameworks have some differences they are all embedded in principles of sustainability, responsive participation, people centeredness, empowering and dynamism (Chambers & Conway 1991; DFID 1999; Ellis 2000; Carney 2003). The framework that was used for analysis in this study is the SLF (Figure 2.1) developed by DFID (1999). The Bebbington's Capitals and Capabilities Framework could not be used due to a number of limitations that it possesses. Firstly the Bebbington's Capitals and Capabilities Framework only analyses types of capital assets and how people combine the assets and transform them to build livelihoods. In this regard the framework put a blind eye on possible vulnerability contexts that the assets may be exposed to and therefore hinder the building of livelihoods. Although people may be having the capital base, the Bebbington's Capitals and Capabilities Framework does not consider external factors. This makes the framework inapplicable to the present study since sustainability is also influenced by external factors. Furthermore the framework's emphasis on social capital as the most important asset for sustainable livelihoods also makes the framework not applicable in this study. This is because, for sustainability to be achieved all factors are of importance. Although the Bebbington's Capitals and Capability Framework considers the importance of assets and their interactions in analyzing rural livelihoods its inability to link the assets to national policies, programmes, livelihoods strategies and livelihoods outcomes makes it inferior to SLF.

SLF was selected as a framework for analysis due to its robust analytical ability (Nicol 2000). The framework is also the most prominent in the field of rural development according to Solesbury (2003) and Knutsson (2006). Nicol (2000) argued that the framework creates linkages between the water sector and a range of parallel socio-economic and policy issues which include decentralization and community based management which are covered in this study. Analyzing sustainability of rural water supplies from a sustainable livelihoods perspective provides a structure for integrating micro level, meso-level as well as macro level factors of sustainability. Such an understanding at various levels of water development may result in the implementation of sustainable water supply systems.

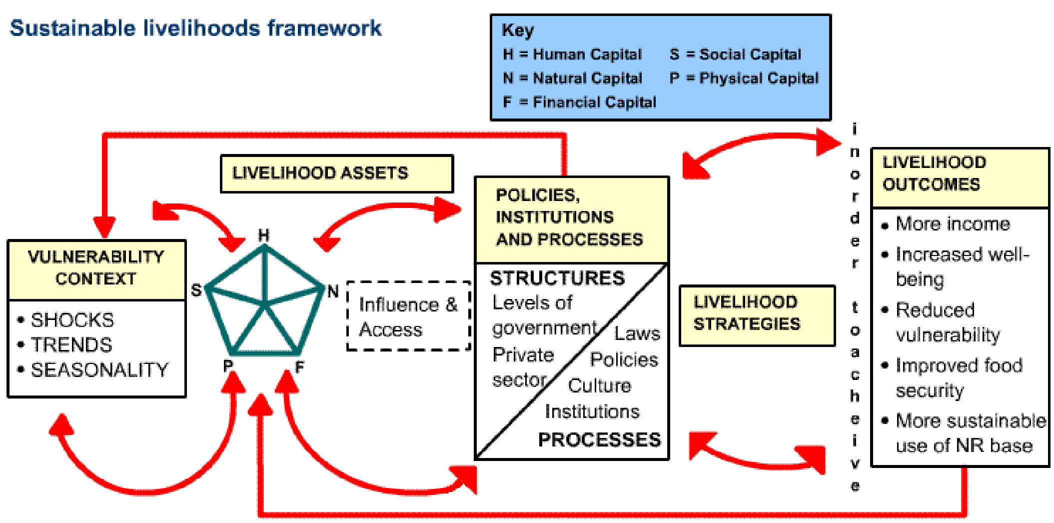

Figure 2.1: Sustainable Livelihoods Framework. Source: DFID (1999)

The SLF has five major components which are the vulnerability context, livelihoods assets, policies, institutions and processes, livelihood strategies and livelihood outcomes (Figure 2.1). These components have different influences on livelihoods and the SLF emphasizes the multiple interactions between them. To situate the framework in the context of the present study these concepts and their interactions will be analyzed in relation to the sustainability of rural water supply. Rural livelihoods and water supply are inseparable in this context since rural livelihoods in sub-Saharan Africa are highly dependent on natural resources and water supply is one of the strategies used to expand and diversify livelihoods activities (Van Koppen et al. 2009; Smits et al. 2010). Furthermore, Zimbabwe like other countries endorsed the concept of sustainable development and its water policy and legislations aim to promote sustainable management of water resources hence the suitability of SLF in this study.

Vulnerability context

Vulnerability context is regarded as the starting point for analysis in the SLF (Carney 2003). Vulnerability context is a key concept related to livelihood sustainability as it normally has adverse effects on the livelihood assets. It is in this regard that the starting point for adopting SLF in this study is an analysis of the vulnerability context within which water points are exposed to. Comparing sustainability of water points in the different districts under study will help to analyze how different environments present different levels of risk in providing sustainable water points (Nicol 2000).

Livelihoods assets

Livelihood assets have been grouped differently by different organizations. CARE grouped livelihood assets into three categories which are human, social and economic (Carney et al. 1999). According to DFID (1999), livelihood assets are categorized into Natural (N), Physical (P), Social (s), Human (H), and Financial (F) capitals. The asset pentagon in the SLF diagrammatically indicates people's access to livelihood assets (Figure 2.1). According to (Carney 2003) the central point of the pentagon, where the lines intersect, stands for zero access to assets while the outer perimeter denotes the greatest access. The shape of the pentagon is not fixed but keeps changing with time when access to assets changes. To put this framework into context this study will adopt the definition of livelihood assets by Scoones (2009) which says assets are resources to attain a livelihood. Using water points as a unit of analysis in this study, assets/ resources in the SLF are conceptualized as factors which influence sustainability. The manifestation of a strong asset base is manifested in reduced vulnerability or increased sustainability of water points.

The factors influencing sustainability were grouped into technical, social, institutional, financial and environmental as they are the recurring factors in literature (Section 2.1). This implies that the natural assets in the SLF were replaced by environmental factors, physical assets were replaced by the technical factors while human factors were replaced by institutional factors in this study. It is crucial to note that no matter how livelihood /sustainability assets/factors are grouped, one common theme is that they are fundamental in determining sustainability. Carney et al. (1999) noted that, the main point of the asset pentagon is to force 'users to think holistically rather than sectorally about the basis of livelihoods". The same concept will be applied in the comprehensive analysis of factors influencing sustainability in this study. Montgomery & Elimelech (2007) argued that sustainability should be assessed based on all factors in a holistic approach as they are interrelated and they complement each other.

Policies and Institutions

Linking micro and the macro levels in the livelihoods framework demands that policy and institutional analysis take place at all levels (Carney et al. 1999). In the rural water sector the policies and institutions mediate between the vulnerability context and the livelihood assets of a community (Nicol 2000). With the adoption of the CBM approach in Zimbabwe as a result of changing policies, SLF was used to understand how the approach is influencing sustainability of water supply systems. Institutional requirements according to the CBM framework and the existing institutional capacity were analyzed. The analysis of institutions was done at local and district levels. The SLF was also applied to contextualize the involvement of a variety of stakeholders and their roles and practices in the provision of sustainable water services. These include NGOs, government departments, Rural District Councils (RDCs) and the water user communities. According to Scoones (1998) the institutional component is vital to uncover structural challenges and opportunities. Such reflections assist in revealing how institutional and government arrangements influence sustainability in rural water supply. An understanding of the challenges and opportunities at different institutional levels was critical in this study in order to to develop solutions that will promote the implementation of sustainable water projects.

Livelihood strategies and outcomes

According to DFID (1999) livelihood strategies are the activities employed to generate the means of household survival. From the resource perspective, Carney et al. (1999) classifies these activities as natural resource based, non-natural resource based and migration. On the other hand almost similar to Carney's classification, Ellis (2000) groups livelihood strategies into two categories which are in Carney's classification except migration activities. In this study this part of the framework was used to analyze the impact of multiple uses of water on sustainability.

Sustainable livelihood outcomes are the achievements or outputs of livelihood strategies (DFID 1999). In SLF, livelihood outcomes focus more on income, increased well-being, reduced vulnerability, improved food security and more sustainable use of natural resources base (Scoones 1998; DFID 1999). Sustainable outcomes for the present study were contextualized by analyzing the outcomes of multiple uses of water on sustainability. The outcomes included improved maintenance of the water points, improved financial performance of water point committees, improved food supply and improved social networks within communities. As noted by Nicol (2000) improved livelihoods outcomes have impacts on the livelihoods assets. Therefore, this enabled the analysis of how different livelihood outcomes impacted on the sustainability of water points.

2.5 Summary

The discourse on sustainability factors has shown that sustainability assessment of water points should consider all factors of financial, technical, environmental, social and institutional factors as they are interrelated. Against this background, most studies have assessed sustainability of water points using a combination of two or three factors and in some instances a combination of sub-factors. Studies done in Zimbabwe have also used a combination of some of these factors and sub-factors in sustainability assessments. This study by using all factors to assess sustainability will provide grounded results on how sustainability is influenced by all factors. However, a key gap that will still be remaining in literature is the absence of a set of validated and consistent metrics of sustainability to assess systems and allow for comparability across studies.

Community participation is a social factor that is important in influencing sustainability of water points. Evidence has shown that community participation creates a sense of ownership although it has been contested that the sense of ownership may not directly translate into willingness to maintain water points. Studies have also shown that, right forms of participation should be used at the appropriate stages of the project cycle hence the need to understand how and at which stage of the project cycle community participation will contribute towards sustainability. Providing external support and capacitating local institutions with the right and adequate skills are key institutional factors. Again, under institutional factors it is of importance to clearly define each stakeholder's responsibilities to avoid overlaps, conflicts and omissions in service delivery.

Literature has also shown that economic factors that influence sustainability include establishment of an O&M fund, regularity of contributions, adequacy and transparency of funds and rules on fee collection. However, under CBM local institutions have to be trained in financial management for sustainability to be achieved. The contribution made by technical and environmental factors towards sustainability has also been documented. However, a gap on the key influential factors of sustainability still exists in Zimbabwe.

Participatory approaches such as the DRA, CBM, PPPs and self-supply and management have been adopted in an effort to promote sustainability of water supply services. Where these approaches are in use, different levels of sustainability have been reported. Despite their participatory nature they have not been a panacea to sustainability challenges. This has shown a need to understand the context in which these approaches work best for sustainability to be achieved. Two or three approaches may be used to complement each other where possible for intended results to be achieved.

Water provision has taken a strategic approach, by considering multiple uses of water in an effort to reduce poverty. This has seen water points being used for domestic purposes as well as small productive purposes such as livestock drinking, brick moulding, beer brewing and gardening. Despite the multiple benefits that multiple uses of water have on rural livelihoods, some development practitioners have ignored the practice. Planning for multiple uses of water by having system adds-on has shown benefits on both people's livelihoods and systems sustainability. If multiple uses of water have an impact on sustainability, an understanding on how it influences sustainability of water points can be used to improve sustainability.

The SLF by (DFID 1999) is the theoretical framework that was used for analysis in this study. The study benefited from the multiple concepts of the framework and their interactions to analyze the complexity of sustainability.

The literature presented in this chapter helped in identifying knowledge gaps on key influential factors of sustainability and how sustainability is influenced by CBM implementation and multiple uses of water. The next chapter will present methods which will be used to collect and analyze data that will be used to fill in the information gaps found in the literature.

3 METHODOLOGY

3.1 Description of study area

Zimbabwe: Zimbabwe is a landlocked country, located in southern Africa with a total area of 390 757 square kilometres (FAO 2012). Its climatic conditions are largely sub-tropical with one rainy season from November to March, a cool winter season from April to August, and the hottest and driest period from September to mid-November. Average annual rainfall is 657 mm per year, but this ranges from over 1 000 mm per year in the Eastern Highlands to around 300-450 mm per year in the southern parts of the country. The population of Zimbabwe according to the 2012 census results was 12 973 808 (Zimstat 2013). The population was made up of 3 076 222 households, with an average of 4.2 persons per household.

Zimbabwe is divided into seven catchments that are based on the major river basins in the country. The catchments have been formed for the purposes of managing the nation's water resources (Government of Zimbabwe 1998). The major rivers which form the basis for the catchments are Save, Runde, Mzingwane, Gwayi, Sanyati, Manyame and Mazowe. These major rivers drain into either Zambezi or Limpopo rivers which both flow through Mozambique to the Indian Ocean.

According to WHO/ UNICEF (2015), 97% of the urban population in Zimbabwe had access to improved water sources compared to 67% in rural areas in 2014. Water is mainly supplied by municipalities, local boards and town councils in urban areas. On the other hand, the provision of water in rural areas was being done by the government until the mid 90s. During the last two decades the provision of rural water supply systems has mainly been done by NGOs while the management is the responsibility of the water users (Makoni & Smits 2007). The main sources of domestic water are wells and boreholes, while dams and rivers are mainly used for productive purposes (Institute of Water and Sanitation Development 2010). However, high yielding boreholes and wells are also used for productive uses such as gardening, brick moulding and livestock drinking (Katsi et al. 2007). The present study was carried out in Chivi District in

Masvingo Province, Gwanda District in Matebeleland South Province, and Nyanga District in Manicaland Province (Figure 3.1).

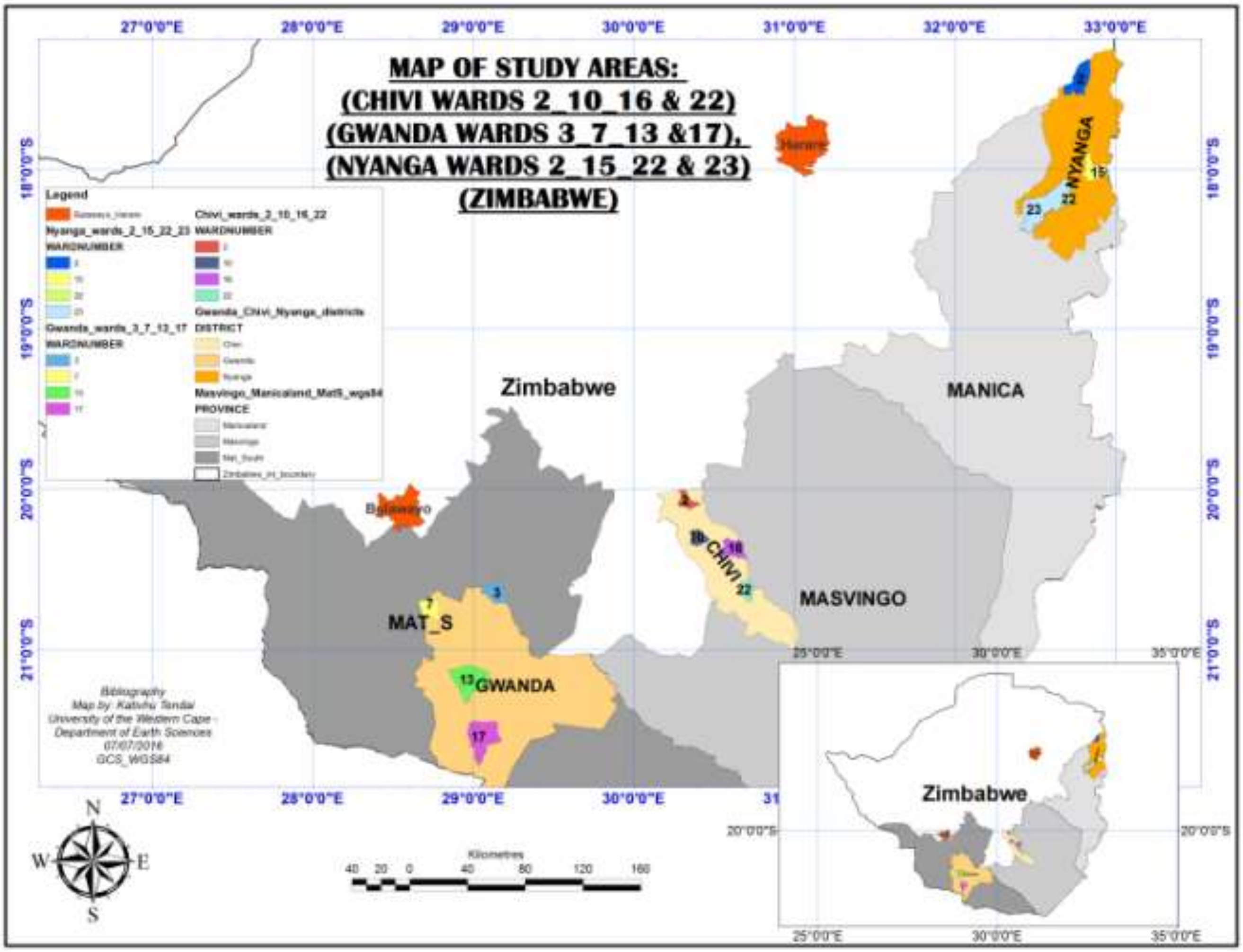

Figure 3.1: The location of study areas in Gwanda, Chivi, and Nyanga districts in Zimbabwe

Gwanda District: The district is situated in the south-west of Zimbabwe in Matabeleland South Province. This district is characterized by low rainfall of between 450-600 mm per year with hot and subject to periodic droughts thereby threatening rain fed agriculture. The landscape of the district is characterized by hilly broken granite country with generally a flat to undulating topography in the southern parts of the district. The main surface water sources in the district include Umzingwane, Shashe, Tuli, Mnyabetsi, Sengezane, Ntswangu and Pelele rivers. The main sources of domestic water are boreholes fitted with bush pumps, wells fitted with windlass and sand abstraction sites fitted with the rower pumps. Some of these sources are also used for productive purposes such as gardening and livestock watering. The major providers of water supply infrastructure in the district are NGOs such as Dabane Trust, Moritioa Sechaba, World Vision, Plan International and Arup.

According to the 2012 national census results, the district had 116 357 people. The number of households in the district were 26 773 with an average of 4.3 people per household (Zimstat 2013). The majority of the district's population lives in communal land areas surrounding a belt of commercial farms around Gwanda Town and to the east around West Nicholson. The primary source of income is cattle raising managed on a commercial basis or as part of subsistence agriculture practiced by peasant farmers (ICRISAT 2008). Although agriculture dominates the source of livelihood, mining activities are carried out in the northern parts of the district. Illegal gold panning and small-scale irrigation of small nutrition gardens are important income and livelihood sources for the rural communities (Dabane Trust 2014). According to the provincial data, the average household income for the district in 2013 was $104 per month (ZimVAC 2013).

Chivi District: This district is in Masvingo Province. The area lies in the low veld area (below 900 meters above sea level). The district is a semi-arid region and is characterized by low rainfall ranging from 450–600 mm per annum. The soils are poor and prone to erosion. There was a total population of 166 277 people in 2012 in the district (Zimstat 2013). Each household in the district had an average of 4.6 people. According to the provincial data, the average household income for Chivi was $80 per month in 2013 (ZimVAC 2013) and the major household source of income was agriculture.

The main surface water sources in the district are Turwi River on the northern part and Runde River on the southern part. The protected water sources used for domestic purposes in the district are boreholes and wells fitted with bush pumps, windlass as well as elephant pumps (ZWP 2009). Some of these sources are also used for productive purposes such as gardening and livestock drinking. The main providers of the water services for the rural communities are NGOs operating in the area, (Government of Zimbabwe 2011). NGOs involved in water supply activities in the district are CARE International in Zimbabwe, Action Contre La Faim, World Vision, Caritas and the International Red Cross Society.

Nyanga District: Nyanga is in the sub-humid region at an altitude of 1 100 to 1 600 meters above mean sea level along the eastern border neighbouring Mozambique. It lies 71 km to the north of Mutare and approximately 265 km east of the capital city, Harare. This is a cool and wet region generally receiving more than 1 000 mm per year rainfall. According to Zimstat (2013) the district had a total population of 125 688 with an average of 3.9 people per household in 2012. Data on household income level is not available at district level in the study area, however at provincial level the average household income was $87 in 2013 (ZimVAC 2013). The main sources of income for rural households in the district are crop production, remittances and casual labour. Communities in the district also supplement their income and livelihoods through community and individual gardening.

The district has significant commercial production of fruits and vegetables. Settlements are on high ground making collection of water a challenge for women and children as they have to contend with steep slopes while carrying water. The water sources used include springs, boreholes, and shallow and deep wells. Organizations that have been implementing water supply projects in Nyanga District are Concern Worldwide Zimbabwe, Zimbabwe National Environment Trust, Wetthungerhilfe (German Agro Action), International Rescue Team, Leveraging Economic Assistance for the Disadvantaged Trust, Caritas Zimbabwe-Mutare, Africare and World Vision Zimbabwe.

3.2 Research Design

A research design is the researcher's overall plan for answering the research question or testing the research hypothesis (Creswell 2003). The plan should include how, where and when data for a research study are to be collected and analyzed. The commonly used types of research designs in rural water supply studies are experimental, case study, cross-sectional and longitudinal (Teddlie & Yu 2007). The selection of a research design is mainly determined by the form of the research questions, the focus of the strategy and its ability to control behavioural events (Yin 1993).

The use of the experimental research design in water management has been prevalent in water quality studies (Spaling et al. 2014). The design has been strongly critiqued on the grounds of reductionism, limited applicability to too many important questions, and limited explanatory power (Smith 2013). These critics and the control that the design has on behavioural events make it unsuitable for the present study. On the other hand, a longitudinal research design follows the same sample over time and makes repeated observations. In water supply studies, these are most appropriate after project implementation when evaluating the impacts of an intervention. Authors who have used longitudinal research design in Zimbabwe are Katsi et al. (2007); Guzha et al. (2007), Masvongo et al. (2012) and Machiwana (2010). Tracking changes over time and relating them to variables that might explain why the changes occur enables the design to provide a richer research picture, particularly well-suited to a study on sustainability. Although the present study used elements of longitudinal design to assess the differences in sustainability performance between the pre-garden and the during-garden periods, only documented variables were considered owing to participants not being able to recall all relevant variables.

A case study is another design that is used in research. It is an in-depth study of a particular research problem rather than a generalized statistical survey or comprehensive comparative inquiry. The literature has shown that this is the commonly used design in studies assessing the sustainability of rural water supply projects. Some studies have used single case studies (Hoko et al. 2009; Quin et al. 2011; Alexander et al. 2015) while others have used multiple case studies. However, where multiple case studies have been used, they were combined with cross-sectional design elements. An example is a study by Whittington et al. (2009) which was conducted in 400 villages with 10,000 respondents. Although a case is often at a relatively small scale such as a single village, the present study will be using a larger scale which is the ‘case” of rural water supply in Zimbabwe.

A cross-sectional research design gives a snapshot of a situation at a given point in time. In this type of research design, either the entire population or a subset is selected to participate in the study. Cross-sectional designs, as opposed to longitudinal designs, require less dedication from research participants, take less time to complete, and do not contain as many obstacles related to finding and maintaining a sample population (Levin 2006; Sedgwick 2014). Although the design does not assess changes over time, which is a critical component for sustainability, its ability to make comparisons of occurrences or incidences of events or instances in varying situations and circumstances by means of observation schedules, questionnaires and interviews makes the design relevant in sustainability studies (Plano-clark et al. 2008).

Given the form of the main research question of this study which seeks to answer the "what" question on sustainability factors and the "how" questions on the influence of CBM and multiple uses of water on sustainability of water supply systems, the case study design combined with the cross-sectional design using survey techniques, was found to be the most appropriate design for the study.

Survey techniques were included in this study since they are the most widely used techniques for gathering data in the social sciences and they are a useful instrument for describing characteristics of large sample populations (Levin 2006). Using survey techniques under the case study design combined with cross-sectional elements enabled the researcher to collect both qualitative and quantitative data for the research question to be answered. A mixed methods approach was therefore used rather than an exclusively qualitative or quantitative methodology. A mixed methods approach is defined as 'research in which the investigator collects, analyses, mixes, and draws inferences from both quantitative and qualitative data in a single study or a program of inquiry (Creswell & Garrett 2008). Its central premise is that the use of quantitative and qualitative approaches in combination provides a better understanding of research problems than either approach alone (Creswell 2009).

The choice of mixed methods was also informed by the fact that views of the world characterized by positivist orientations can be misleading, requiring that researchers approach complex, multifaceted and dynamic research phenomena from different perspectives and paradigms so as to gain a holistic perspective about a phenomena under study (Small 2010). Sustainability of water supply being a complex issue and difficult to assess phenomenon, combining methods and empirical materials helped the researcher to overcome the weaknesses or intrinsic biases and problems that come from using a single method (Johnson & Onwuegbuzie 2004).

The mixed methods designs are broadly categorized into sequential and concurrent designs. According to Creswell (2009) the sequential designs can further be divided into sequential exploratory, sequential explanatory and sequential transformative designs. On the other hand, the concurrent designs are divided into concurrent triangulation, concurrent embedded, and concurrent transformative designs. Therefore, after choosing the mixed methods approach, the researcher had to choose the most appropriate type of mixed methods design to be used in the study.

The sequential explanatory strategy is when data collection and analysis of quantitative data is followed by the collection and analysis of qualitative data (Creswell 2013). The purpose of the design is to use qualitative results to assist in explaining and interpreting the findings of a primarily quantitative study. The design has been found to be useful when unexpected results arise from a quantitative study (Creswell 2013). The major weakness of the design is the long data collection time due to there being two phases of data collection involved. Sequential exploratory strategy is in reverse order from the sequential explanatory strategy to support the interpretation of qualitative data collection and analysis by using quantitative data and results. Hence priority is given to the qualitative aspect of the study when using the design. The sequential transformative strategy has a theoretical perspective to guide the study. The aim of this theoretical perspective, whether it be a conceptual framework, a specific ideology, or advocacy, is more important in guiding the study than the use of methods alone; hence in this design any method can be used first.

Concurrent triangulation is the most familiar of the six major mixed methods designs (Creswell, 2009). The strategy uses separate quantitative and qualitative methods as a way of complementing underlying weaknesses of one method with the strengths of the other. It is used when two different methods are applied in an attempt to confirm, cross-validate, or corroborate findings within a single study (Cameron 2011; Harrison & Reilly 2011). As compared to any one of the sequential strategies, this strategy collects data in a shorter period. Like the concurrent triangulation approach, the concurrent nested and the concurrent transformative approaches also have one data collection phase where both quantitative and qualitative data are collected simultaneously (Creswell 2009). However, the concurrent embedded design is useful to analyze similar topics or different questions in different degrees, while concurrent transformative approach seeks for rational perspective from both quantitative and qualitative data collected concurrently (Teddlie & Han 2015).

The current study used the concurrent triangulation strategy for triangulation and strengthening weaknesses of both quantitative and qualitative methods.

3.3 Sampling

In research, a sample is a finite part of a statistical population whose properties are studied to gain information about the whole (Cameron 2009). Sampling is of great significance as this determines the degree to which a study has wider relevance (Marshall 1996; De Vos 2002). Due to the nature of the research design (mixed methods) applied in this study, both probability and non-probability sampling methods were used in the selection of study participants (Teddlie & Yu 2007). Probability sampling was used to enable statistical inferences of sustainability factors to be made. The types of probability techniques used were simple random sampling and stratified random sampling. On the other hand, non-probability sampling was used to select participants based on theoretical reasons and the sampling technique which was used is purposive.

Sampling was done in four stages and different techniques were used at each stage (Onwuegbuzie et al. 2007). These stages were the provincial, district, ward and water point. Purposive sampling was used to select three provinces out of a total of ten provinces in Zimbabwe. Since the focus of the study was to assess sustainability of communally-managed water points, the selected provinces had the highest number of communally-managed water supply points (WASH Atlas 2011). The selected provinces were Manicaland, Matabeleland South and Masvingo.

The selection of districts was also purposive where the districts with the highest number of NGOs implementing water projects at the time of the study were selected. The selection was also based on the types of water lifting devices, where the district with all types of water lifting devices used in the province was preferred. Resultantly, Chivi District in Masvingo Province, Nyanga District in Manicaland Province and Gwanda District in Matabeleland Province were selected.

Stratified random sampling was used to select wards within the study districts. A total of four wards were selected in each district. The districts were stratified according to constituencies. Chivi and Gwanda districts have three constituencies while Nyanga has two. The constituencies in Chivi District are Chivi Central, Chivi South and Chivi North, and Nyanga District has Nyanga North and Nyanga South constituencies. In Gwanda District there is Gwanda North, Gwanda South, and Gwanda Central constituencies. At least one ward was randomly selected in each constituency in the three districts. The selected wards are shown in Table 3.1.

Table 3.1: Selected wards and number of water points per district

District	**Constituent**	**Ward No**	**No of water points per district**
Chivi	Central	16	131
	North	2 &10	
	South	22	
Gwanda	Central	13	194
	South	17	
	North	3&10	
Nyanga	North	2	134
	South	15, 23& 24	
Total		**12**	**459**

All communally-managed water points in the selected wards were selected for sustainability analysis. Databases for communally-managed water points from the National Coordination Unit (NCU) office as well as the District Development Fund (DDF) offices in the study sites were used to compile a list of water points to be studied in each district. Communities also assisted the researcher to identify water points which were missing on the databases so as to come up with a complete list. Resultantly, 459 water points were selected in the three districts and the distribution per district is shown in Table 3.1.

The reason for including all communally-managed water points in the study was due to the type of analysis (Exploratory Factor Analysis (EFA) which was to be done. Pearson & Mundform (2010) noted that it is important to consider the minimum necessary sample size when planning for a research so as to obtain reliable results from statistical procedures. Literature has provided different recommendations on the sample size for studies using EFA. Winter et al. (2009) and Leech & Onwuegbuzie (2011) suggested sampling at least 100 subjects while Comrey & Lee (1992) provided a scale of sample size adequacy. Their scale shows that, 50 – very poor, 100 – poor, 200 – fair, 300 – good, 500 – very good, and 1,000 or more – excellent. However, Pearson & Mundform (2010) argued that a sample size of hundred is enough to achieve a good level of agreement for models having one or two factors. Since the current study analyzed five factors of sustainability, all the 459 water points were included in the study.

Stratified random sampling was used to select water points used for multiple uses. The groups of water points which were considered under multiple uses are; water points providing water for domestic uses and community gardening, water points providing water for domestic uses and livestock watering and those providing water for domestic uses, community gardening, and livestock watering. To answer the question on how multiple uses of water is influencing the sustainability of water points (see Section 1.9), a fourth group of water points which consisted of water points used for domestic uses only was selected. Notably, all the water points used for community gardening across the three districts were selected in the study. It was noted that although water troughs were found at almost 85% of the water points, they were not being used in most cases in Chivi and Nyanga districts. In this regard, only water points with water troughs which were being used were targeted for the study in the two districts. However, in Gwanda district, 95% of the water points had water troughs which were being used. The water points were stratified into wards and random sampling was used to select the studied water points. The targeted number of water points used for multiple uses per ward, was the same as that of the targeted water points used for domestic purposes only in that ward. Random sampling was used to select water points used for domestic purposes only. The targeted number of water points providing water for multiple uses and domestic purposes only per district are shown in Table 3.2.

Table 3.2: Targeted water points used for multiple uses and domestic uses only per district

District	Description of use			
	Multiple uses			**Domestic purposes**
	Community gardening and domestic	Livestock drinking and domestic	Community gardening, livestock drinking and domestic	Domestic only
Chivi	13	5	0	18
Gwanda	6	28	0	34
Nyanga	21	5	4	30
Total	**40**	**38**	**4**	**82**

Stratified random sampling was used to select participants at household level. The participants were classified into two distinct groups where the first group were households who use water points which are used for multiple uses and the second group were households who use water points which are solely used for domestic purposes. A total of 50 households were targeted from each group per district resulting in a total of 100 households being targeted per district. Random sampling was then used to select households that would participate from each group.

Purposive sampling was used to select Focus Group Discussion (FGD) participants and Key Informants (KIs). The designation and the reasons for selecting participants for FGDs and KIs are presented in Sections 3.4.2 and 3.4.3. Krueger and Casey's (2000) suggestion of recruiting between six and eight participants per FGD session was considered. Two FGD sessions with 8 participants each were conducted in each ward. Key informant interview participants at national, district and ward level were those with knowledge on the subject matter under discussion. A total of six participants were selected at national level while fifteen participants were selected at district level. At ward level two key informants were interviewed per ward and these were mainly community leaders.

3.4 Data Collection Methods

The data collection methods which were used in this study to fulfill the requirements of the mixed research design are questionnaires, key informant interviews, focus group discussions, document analysis, participatory research and observations.

3.4.1 Questionnaires

The use of questionnaires involves the collection of data from a sample population in order to make inferences from the results (Krueger & Krueger 2000; Masadeh 2012). Two types of questionnaires were used to collect quantitative data for the study. One questionnaire was administered to households while the other one was administered to water point committees. Both questionnaires had closed and open-ended questions. The use of closed-ended questions enabled the researcher to collect data quantitatively with pre-selected options, while open-ended questions provided an opportunity for the respondents to respond and express their opinions. Results from open-ended questions were then coded for analysis. The use of questionnaires is often criticized for being rigid (Chambers 1994). An example in rural water studies is the experience by Haysom (2006) whose questionnaire was rigid in a study done in Tanzania. In the present study the results of the pilot study and the use of focus group discussions and key informant interviews helped to avoid rigidity in the tool such that all the required information could be gathered. Critical themes that came up from open-ended questions during the pilot study were useful in the development and refinement of key informant interview and focus group discussion guides.

Water Point Committee (WPC) questionnaire

A total of 459 questionnaires were administered to Water Point Committees (WPC) in 12 wards selected for this study. The information required related to the technical, social, economic, financial and institutional performance of the water points. Under each factor several sub-factors / variables were considered. The factors and sub-factors are shown in Table 3.3 and the sample questionnaire is shown in Appendix 3.1.

Table 3.3: Factors and sub-factors used to assess sustainability

Factors	Sub factors/variables	Type	Response
1. Technical	1.1 Availability of spare parts 1.2 Affordability of spare parts 1.3 Pump status 1.4 Functionality	Binary Binary Binary Binary	Yes or no Yes or no Good, Fair, Bad Yes or no
2. Social	2.1 Community participation in planning 2.2 Community participation in operation and maintenance 2.3 Proportion of men and women in WPC 2.4 Conflict management	Ordinal Ordinal Numerical Ordinal	High, medium, low High, Medium, Low Number Good, Fair, Poor
3. Financial	3.1 Establishment and existence of operation and maintenance fund 3.2 Regularity of making contributions 3.3 Adequacy of funds 3.4 Transparency in use of funds 3.5 Rules regarding fee collection	Binary Ordinal Binary Binary Binary	Yes or no Weekly, Monthly, after a break down. Yes or no Yes or no Yes or no
4. Institutional	4.1 Existence of user committees 4.2 Functionality of user committees 4.3 Availability of external support 4.4 Adequacy of training 4.5 Rules on water point use and management 4.6 Adequacy of skills for VPMs 4.7 Adequacy of skills for WPCs 4.8 CBM training	Binary Binary Ordinal Ordinal Binary Binary Binary Binary	Yes or no Yes or no Good, Average, Poor Adequate, Average, Inadequate Yes or no Yes or no Yes or no Yes or no
5. Environmental	5.1 Adequacy of water supply 5.2 Water quality at source 5.3 Potential for contamination	Binary Ordinal Ordinal	Yes or no Excellent, Good, Bad High, Medium, Low

The WPC questionnaire also sought to collect information on how multiple uses of water influence sustainability of water systems. To answer this question, a total of 164 water points were targeted and how these were selected is discussed in section 3.3.

__Household questionnaire__

Chivi District had a total of 36 382 households in 2012 while Nyanga had 32 359 and Gwanda had 26 773 (Zimstat 2013). A total of 300 households were sampled across the three districts. The sampling technique used to select the households is described in Section 3.3. From the sample, 150 households were water users whose water points are for gardening and livestock watering while the other 150 households were those whose water points are for domestic purposes only. The interviewed person in a household was someone who made decisions about water collection and use in the house on a daily basis. The household questionnaire was divided into sections which collected information on socio-economic characteristics, water access, and influence of multiple uses of water on livelihoods and sustainability of water supply systems. The sample questionnaire is shown in Appendix 3.2.

3.4.2 Key Informant Interviews (KIIs)

Questionnaires provided broader information on the research question, therefore for depth and to answer questions on why things happen KIIs and FGDs were used (Dicicco-bloom & Crabtree 2006; Masadeh 2012). The KIIs were also used since individual values, and attitudes may not be accommodated in a formal questionnaire (Byrne & Humble 2007). A total of 33 interviews were conducted, 6 at national level, 15 at district level and 12 at ward level. Key informants at national level were from the National Coordination Unit (NCU) which is the secretariat of the National Action Committee (NAC). The NAC is an inter-ministerial committee responsible for the coordination and mobilization of resources for the development of water and sanitation facilities. The positions of the NCU respondents were the National Coordinator and the Rural Water and Sanitation Officer. Personnel from the Ministry of Environment, Water and Climate, and NGOs implementing water supply projects in the districts under study were also interviewed at national level. The position of the personnel interviewed within the ministry was the Water Management Officer, and within the NGOs the Water and Sanitation Managers were interviewed. These participants were selected as they were considered to be experienced in rural water supply projects coordination, implementation and management at national level. Their experience and knowledge on national water policies, programmes and other legal frameworks also made these participants key in this study. Fifteen key informants who were selected at district level were members of the District Water and Sanitation Sub-Committees (DWSSCs). Their selection was based on the fact that they are the ones who oversee the implementation and management of rural water systems at district level. Participation at ward level was by community leaders such as councillors, chiefs, village heads who had knowledge about water access and management in their wards. NGO field workers who operated at ward level were also part of the key informants.

Semi-structured interviews were conducted using interview guides with both closed-ended and open-ended questions. Since key informants were sampled from ward, district and national levels, the questions in the interview guides were slightly different (Appendix 3.3, 3.4 and 3.5). The use of interview guides served to solicit information from respondents systematically and comprehensively as well as keeping the interview focused. Open-ended questions were used as they allowed the researcher the flexibility to pursue issues as they arose. Open-ended questions also enabled the researcher to probe issues under discussion. The questions progressed from simple (opening and introduction questions) to complex (transition and key questions) and back to simple (ending questions). All the interviews were recorded. Recording the interviews allowed the researcher to focus on the interview content (Creswell & Garrett 2008). However, handwritten notes were taken down by a research assistant throughout the interviews and these guided follow up questions. The recorded interviews were listened to on the same day the interviews were conducted.

3.4.3 Focus Group Discussions (FDGs)

Two focus group discussion sessions were conducted in each ward. Participants were divided into two groups, with one group having community leaders such as village heads and councillors, while the other group had Village Health Workers (VHWs), Village Pump Minders (VPMs) and WPCs. Separating FGDs participants into two groups was done so that participants would feel comfortable discussing issues with others who shared similar experiences when sensitive issues were being explored (Breen 2006). FGDs were used as they are highly efficient in collecting a wide range of data from several people at the same time (Sofaer 2002). This enabled the researcher to gather information on attitudes, feelings and experience of the groups which could not be derived from the other methods of the mixed methodology which were employed. It also allowed the researcher to develop an understanding about why people feel the way they do on certain issues and why certain water management practices were adopted within the communities (Byrne & Humble 2007). Since FGDs are concerned with accounts that emerge through interaction, the comparisons that participants made among each other's experiences and opinions were a valuable source of insights into complex issues such as sustainability (Lakshman et al. 2000).

Data collected through FGDs was enhanced by group dynamics that aid recall and elaboration. The use of FGDs also provided participants with an opportunity to create new ideas that they probably would not have thought of without hearing the views of others (Byrne & Humble 2007). This data collection method became very timely in identifying issues on which there was consensus or disagreement within the groups. Proceedings of the sessions were recorded on a voice recorder while hand written notes were taken mainly as probe points.

3.4.4 Participatory observations

Observation is a way of gathering data by watching behaviour, events or noting physical characteristics in their natural setting. In this regard, the researcher considered that the context of the research itself would be part of the reality in which the participants live and experience daily triumphs and struggles in trying to sustain their water supply systems (Mabiza 2013). The observations which were made during water management meetings enabled the researcher to understand the power relations of groups and/or individuals which may have an impact on institutional sustainability. The contested terrains which were observed between the poor and the rich, and also between men and women yielded important insights into how such relationships impact on sustainability. Such contestations which are often not expressed verbally by research participants also enabled the researcher to understand how different groups of people participate in water management and how they access water for both productive and domestic purposes. Such hidden and often unspoken actions were found to be loaded with meaning and they served as a means of confirming information given by respondents in the questionnaires and during interviews and FGDs.

Observations were also done to check the physical status of the water points and their surroundings. In this regard a checklist was used. The compiled list was checking against the status of the aprons of boreholes, whether they had cracks or not as it may be a potential source of contamination. Observations were also done to check if water points had any loose parts and if the parts were greased. The surrounding environments were checked for cleanliness and if the water points were fenced to protect animals from soiling the surrounding environments. Where water points had water troughs for livestock and laundry facilities, their position from the water point and their physical status were also observed as they are also a potential source of contamination. Observations were also made on the availability of sanitary facilities at water points, particularly those used for community gardening. The sanitary facilities are critical as people spend a lot of time at the water point doing their garden activities hence their absence may promote open defecation near the water sources.

3.4.5 Document analysis

Document analysis involved data identification and collection from organizational and institutional documents. Both printed and electronic documents were reviewed. The reviewed documents were from NGOs, Rural District Councils (RDCs), and WPCs. Institutional and organizational records were considered to be critical data sources as they provide empirical evidence about the context within which different stakeholders in the rural water sector operate (Breen 2006). Bowen (2009) referred to this as a “case of text providing context” which is important in social sciences since the text and images in the records would have been recorded without the researcher’s intervention. The types of documents reviewed in this study include meeting agendas, attendance registers, and minutes which were obtained from WPCs and the DWSSCs. Documents of water points used for community gardening provided background and historical information on how multiple uses of water have affected sustainability. This allowed comparisons of sustainability between the pre-garden and during-garden periods to be made. Efforts to get records of meetings from some NGOs and RDCs were in vain due to confidential issues which are discussed in these meetings.

At water point level, WPCs also provided records about their financial performance. Although the aim of reviewing such records was to investigate whether user communities were making financial contributions towards O&M or not, the way the information was recorded also revealed the level of managerial and financial skills that the local institutions had. Training manuals and programmes on CBM, background papers on Water Sanitation and Hygiene (WASH) as well as brochures were also reviewed. These documents were obtained from the NCU, RDCs as well as NGOs. NGOs were also a rich source of organizational reports, survey data and photo albums (Bowen 2009). Information provided by these documents suggested some questions which were asked during KIIs as well as some observations which were done in the field. The review and analysis of policy and guidelines documents obtained from NCU also facilitated a deeper understanding of the dichotomy of theory and practice on CBM implementation. The contextual limitations on the implementation of the CBM approach were also made clear through document analysis. Since document analysis was used as a way to verify findings or corroborate evidence from other sources (Breen 2006), further investigations were done where contradictory evidence was found.

3.4.6 Participatory research

According to Onwuegbuzie (2009) participatory research is when members of the community or a specific group from a community collaborate in the identification of problems, collection of data and analysis of their own situation in order to improve it. It is based on the principles of participation and self-development as it treats people as “research participants” rather than “research subjects” and it is also research “within” rather than “on” people (Leech & Onwuegbuzie 2011). In this study, participatory research techniques were used to collect data on the relative importance of different factors of sustainability through a ranking exercise. Professionals in the WASH sector at district level participated in workshops organized by the researcher during which sustainability factors were assigned weights based on their importance in influencing sustainability. Participatory research was critical as this enhanced the understanding of social reality from people’s perspectives and experiences which could not be provided by other methods used in the study. Since this research also aimed at analyzing how the implementation of policy frameworks (CBM) influences sustainability, the in-depth and context-based nature of participatory research provided good insights for policy actions. If the results of the study are going to be taken up by policy makers it will enable the incorporation of local knowledge into the broader policy dialogue process which will increase the relevance and effectiveness of water policies. After identifying the relative importance of the various factors, solutions to the sustainability problems were suggested. This provided good opportunities for the participants to re-think and re-interpret their situation, which in turn might increase the relevance and applicability of the research findings of this study to address sustainability challenges.

3.5 Quantitative data analysis

Quantitative data collected through questionnaires were cleaned and coded. These data were then analyzed with the help of the Statistical Package for Social Science (SPSS version 22). Double entry was done to check for possible mistakes. Both descriptive and inferential data analysis methods were done.

3.5.1 Descriptive statistics

Descriptive statistics such as means, maximum, minimum, standard deviations and frequencies were used to provide comparisons on the socio-economic status of responds as well as water supply status in different districts. Descriptive statistics also provided a concise summary of data on various sustainability factors across the three districts under study.

3.5.2 Multi-Criteria Analysis (MCA)

Multi Criteria Analysis (MCA) was used to determine weights of sustainability factors. The advantage of the MCA method is that this enables an integrated assessment of subjective and objective information with stakeholders' values in a single framework (Saaty 1987). This allowed comparisons to be made on how important different factors of sustainability are.

Determining weights of factors using the Analytic Hierarchy Process (AHP)

To determine weights for the different sustainability factors, the Analytic Hierarchy Process (AHP) was used. The AHP is a theory of measurement through pairwise comparisons of the various competing alternatives (Saaty 1987). The process uses hierarchical structures to represent a problem and this relies on the judgements of experts to derive priority scales which measure intangibles in relative terms. The comparisons are made using a scale of absolute judgements that represents, how much more one element dominates another, with respect to a given attribute (Saaty 2008).

The AHP has been of great interest to researchers in many different fields due to its concise mathematics and easily obtained input data, (Bahurmoz 2006). The greatest strength of the AHP is that, although its foundation lies in complex matrix manipulation, it can be employed by those with little knowledge of the optimization theory and its computational phases are easily executed by employing familiar desktop software such as Microsoft Excel (Saaty 2003). AHP is also a powerful tool capable of considering an unlimited number of influential criteria exhibiting different units or no units at all (Wang & Chin 2011).

Several studies have used the AHP method to assess sustainability in the water sector (Ramanathan 2001; David 2007; Ishizaka & Labib 2011). In this study, field experts at district level compared the different factors in terms of how important they are in influencing sustainability. Pairwise comparisons were done between sustainability factors which are environmental, financial, technical, social and institutional. For example the environmental factor was first compared against the technical factor, secondly against the financial factor, thirdly against the social factor and lastly the institutional factor. The comparisons were later done between all the sub-factors which are presented in Table 3.4. These factors and sub-factors were derived from literature on rural water supply and they were found to be the most recurring.

Table 3.4: Factors and sub-factors used in the AHP

Factors	Sub-factors
Technical	Availability of spare parts
	Affordability of spare parts
	Functionality
	Water point status
Social	Community participation in planning
	Community participation in O&M
	Proportion of men and women in WPC
	Conflict management
Institutional	Existence of committees
	Functionality of committees
	Training in CBM
	Level of external support
	Availability of rules
Financial	Presence of O&M fund
	Frequency of making financial contributions
	Transparency on use of funds
	Presence of rules on fee collection
Environmental	Reliability of water supply
	Water quality at source
	Potential for contamination

To assist in the weighting process, the Saaty's pairwise comparison table (Table 3.5) was used. The table determines the dimensionless scale of relative importance where field experts in this study had to express their opinion about the value of one single pairwise comparison at a time (Saaty 1980).

Table 3.5: The fundamentals scale for pairwise comparisons

Intensity of importance	Definition	Explanation
1	Equal importance	Two elements contribute equally to the objective
3	Moderate importance	Experience and judgement slightly favour one element over another
5	Strong importance	Experience and judgement strongly favour one element over another
7	Very strong importance	One element is favoured very strongly over another, its dominance is demonstrated in practice
9	Extreme importance	The evidence of favouring one element over another is of the highest possible order of affirmation
Intensities of 2, 4, 6, and 8 can be used to express intermediate values. The intensities 1.1, 1.2, 1.3 etc can be used for elements that are very close in importance.		

***Source*:** Saaty (2008)

Within every hierarchal comparison matrix, the experts had to compare each competing alternative against every other competing alternative employing a scale of relative importance. This type of comparison was executed for each factor and sub-factor and this allowed the construction of judgment matrices for the factors and sub-factors. The judgment matrices had the dimensions, MxM, where "M" is the total number of alternatives considered. In this study, the judgement matrix for sustainability factors was equal to five (5x5). The dimensions of the matrices for sub-factors were determined by the number of sub-factors under each factor.

After computing the judgement matrices, principal eigenvectors were calculated by summing up elements in each row of the matrix and then normalising them by dividing each sum by the total of all the row sums (Saaty 1980). To validate the judgemental matrix weighting, a measure of consistency was calculated. The consistency was calculated by firstly multiplying the original judgment matrix by the estimated, normalized priority which is termed $A_{VE.}$ The resulting vector was termed A_W (Young & Loganathan 2006). Then, the first component of the A_W vector was divided by the first component of the estimated solution vector. The process of dividing each entry of vector A_W by the corresponding entry of the estimated solution vector A_{VE} was done for all the components. Upon completing this step, the maximum eigen value was estimated as the average of all the entries. The formula for calculating the maximum eigen value is as follows;

$$\lambda\max = \frac{A_W}{A_{VE}} \tag{3.1}$$

Where: λmax = maximum Eigen value

The maximum Eigen value was then used to compute the matrix consistency using the following formula;

$$\frac{CI = \lambda\max - n}{n-1} \tag{3.2}$$

Where: CI = consistency index

λmax = maximum Eigen value

N =number of criteria.

The consistency of the judgement matrices was interpreted as shown in Table 3.6

Table 3.6: Consistency index interpretation

Consistency Index	**Interpretation**
0	judgments are perfectly consistent
≤ 0.1	consistent enough
≥ 0.1	matrix needs improvement
≥0.9	judgments are just about random and are completely untrustworthy

The total weights of all the factors add up to 1, which in this case is the weight of sustainability which is the overall goal of the AHP.

Performance scoring

Several questions were asked to WPCs and water users to assess the field performance of each sub-factor. Data were assigned scores using the methodology developed by Kaliba (2002). The methodology is based upon the principle that 1 represents a positive contribution towards a sub-factor and 0 represents no contribution. The methodology was adopted since it is suitable for the assessment of the sustainability of rural water supply systems (Peter & Nkambule 2012). The methodology by Kaliba also enables the quantification of performance by water supply systems. Sara & Katz (1997) also used similar techniques based on primary data collected using a structured questionnaire. In their study for each question asked, a score was given for each response as follows; if the response contributed positively towards sustainability, the response scored a +2. If the response did not contribute positively, it was given a score of 0. If the response indicated neither positive nor negative performance, it scored a +1. The responses were then aggregated at the project level as indices of sustainability. Table 3.7 shows an example of the scoring system when functionality of water user committees as a sub-factor under institutional factors was quantified in this study.

Table 3.7: Performance scoring on functionality of water user committees

Data Type	**Example of question from WPCs' questionnaire**	**Score**
Binary	Does the water point have a WPC	Yes = 1 No = 0
Ordinal	How would you rate the level of participation by the WPC members	Excellent = 1 Good = 0.50 Poor = 0
Binary	Does the WPC have a constitution	Yes = 1 No = 0
Binary	Does the water point have a Maintenance Committee (MC)	Yes = 1 No= 0
Binary	Does the MC have adequate skills	Yes =1 No =0
Binary	Does the MC have adequate tools	Yes =1 No =0
Ordinal	How would you rate the level of participation by the MC members	Excellent = 1 Good = 0.50 Poor = 0

All the sub-factors were scored in the field as shown in the example given in Table 3.7. Triangulation was done through observations and checking water point records.

Sustainability Classification

The weight of each factor which was assigned through the AHP was then multiplied by the factor's performance score obtained in the field to get the sustainability score of that factor. The summation of the sustainability scores for all the factors then gave the overall sustainability score of an individual water point so that it was classified as highly sustainable, sustainable, partially sustainable or not sustainable as shown in Table 3.8.

Table 3.8: Sustainability classification of water points

Classification	**Range of measurement**	**Sustainability category**
Very Good	75-100%	Highly sustainable (HS)
Good	50-74%	Sustainable (S)
Fair	25-49%	Partially sustainable (PS)
Poor	Below 25%	Not Sustainable (NS)

All the water points were then classified according to their sustainability scores.

3.5.3 Exploratory Factor Analysis (EFA)

Exploratory Factor Analysis (EFA) was used to determine the key influential factors of sustainability. Factor analysis is based on the fundamental assumption that, some underlying factors, which are fewer than the number of observed variables, are responsible for the co-variation among the observed variables (Tabachnick & Fidell 2008). Based on this assumption, factor analysis was noted to be the most appropriate method to address the question in objective one on "what are the principal factors influencing sustainability". As a data reduction method, the aim of EFA is to retain the fewest possible factors that explain the highest amount of variance (Henson & Roberts 2006). EFA was used instead of the Confirmatory Factor Analysis (CFA) since the researcher did not know how many underlying dimensions there were for the given data (Beavers et al. 2013).

At the sampling stage of this study the researcher considered the adequacy of the sample since an inadequate sample size can be detrimental to the factor analytic process and produce unreliable, and therefore, non-valid results (Comrey & Lee 1992; Kline 1994) (see Section 3.3).

Factor Extraction

Factor extraction identifies the components that best characterize a set of variables (Beavers et al. 2013). The most frequently used methods in factor extraction are principal-axis factoring (PAF), principal components analysis (PCA), and the maximum likelihood (ML) method. In this study the PAF was used as it requires no distributional assumptions and may be used if data are not normally distributed (Fabrigar et al. 1999). ML was not considered as it requires multivariate normality (Pett et al. 2003). Although PCA is the most popular factor extraction method, it was not used since it is appropriate if the researcher's purpose is pure reduction of variables without interpreting the resulting variables in terms of latent constructs (Beavers et al. 2013). This was found to be a limiting factor in this research as some of the explanations behind sustainability may not be observable since they are influenced by certain behaviours of water users.

Numerous methods are used to determine the number of factors to be retained after factor extraction. Among the methods is Kaiser's criteria (Eigen value > 1 rule), the Scree test, the cumulative percent of variance extracted and parallel analysis (Hair et al. 1995). However, given the choice and sometimes confusing nature of factor analysis, no single criteria should be assumed to determine factor extraction (Hair et al. 1995; Williams et al. 2010). Since literature has emphasized on simultaneous use of multiple decision rules, this study used three methods. The first method was the Eigen value > 1 rule, where all factors with an Eigen value above one were retained (Kaiser et al. 1974). Secondly, the cumulative percentage of variance method was used. Although no fixed threshold exists for this method certain percentages have been suggested for different fields. According to Hair et al. (1995) in the natural sciences factors should be stopped when at least 95% of the variance is explained while in the humanities, the explained variance is commonly as low as 50-60%. However, this study used the 75-90% variance explained suggested for all fields (Gorsuch 1990; Pett et al. 2003) The Scree plot was also considered in this study where the number of factors retained was the data points above the break

(Williams 2012). To determine the 'break' a horizontal and a vertical line were drawn starting from each end of the curve (Hair et al. 1995).

Factor rotation

Factors were rotated for better interpretation since unrotated factors are ambiguous (Beavers et al. 2013). The goal of rotation is to attain an optimal simple structure which attempts to have each variable load on as few factors as possible, but maximizing the number of high loadings on each variable (Williams 2010). Rotation methods are broadly categorized into two; orthogonal and oblique (referring to the angle maintained between the X and Y axes). Orthogonal rotations produce factors that are uncorrelated while oblique methods allow the factors to correlate (Osborne 2015). Under each category there are a variety of choices where under orthogonal rotation there are varimax, quartimax and equamax rotations. On the other hand oblique rotation is further categorized into direct oblimin, quartimin and promax. Both approaches to factor rotation seek to achieve the same results: a simple structure and thus an interpretable solution. The rotation method which was used in this study is the promax under oblique rotation. It was chosen as it produces factors that are correlated, which is often seen as producing more accurate results for research (Costello & Osborne 2005).

Traditionally, although researchers have been guided to orthogonal rotation because its results are uncorrelated and easily interpretable the method has received some critiques which resulted in oblique – promax being the best method for this study. According to Osborne (2015) in social sciences it is generally expected that there exists some correlation factors since behaviour is rarely partitioned into neatly packaged units that function independently of one another. Using orthogonal rotation in the study of key factors influencing sustainability therefore, potentially resulted in a less useful solution where factors are correlated. Furthermore, considering that EFA is an exploratory technique (not a confirmatory technique) the clearest solutions possible should be sought (Osborne 2015). To determine the items that defined the sustainability factors the recommendation by Comrey and Lee (1992) of loadings greater than .30 was used.

3.5.4 Assessment of sustainability performance for water points used for multiple uses and those used for domestic uses only

Independent samples t-test

The independent samples t-test was used to answer objective 4 of the study on how multiple uses of water influence sustainability (Section 1.8.2). The test was used to compare the means of performance for sub-factors and factors between water points used for domestic uses only and water points used for multiple uses. Notably, only sub-factors and factors which had data available across the selected water points were considered to allow comparisons to be made. The test uses the t statistic and its p-value to analyze the significance of the difference in sample means. Independent t-test is calculated using the formula below.

$$t = \frac{(\overline{x}_{1} - \bar{x}_2)}{\sqrt{\{S_p^2(\frac{1}{n_1}+\frac{1}{n_2})\}}} \qquad (3.3)$$

Where: S_p^2 = the pooled variance

n_1 = sample size in group 1

n_2 = sample size in group 2

x_1 = sample mean of group 1

x_2 = sample mean of group 2

The data was checked for outliers and the Shapiro Wilks test was used to test the assumption for normality (Ghasemi & Zanediasl 2012). The Levene's F test for equality of variance was used to test for homogeneity of variance since it is the most commonly used statistic to test for the assumption (Nordstokke & Zumbo 2010). The hypotheses which were tested using this test are explained in Section 6.2. The 5% level of significance was used to determine if two sample means were significantly different.

Paired samples t-test

Paired samples t-test was used to detect changes in factor performance before and after the implementation of community gardens. The test could not be done for water points which are used for livestock drinking because water troughs were constructed at the same time when the water points were installed. However, gardens were implemented when the water points were already in use. Factors which were analyzed using this test were those which were documented for the pre-garden period due to recalling challenges when using historical data. The formula for the paired samples t-test is as follows:

$$t = \frac{\bar{d}}{\left(\frac{S_{\bar{d}}}{\sqrt{n}}\right)} \qquad (3.4)$$

Where: $\bar{d}$ = mean difference

$S_{\bar{d}}$ = Standard deviation of the differences between paired observations

The test was used to examine at the 5% significance level whether there were differences between the two periods based on the factors which are explained in Section 6.2.

3.6 Qualitative data analysis

Thematic analysis was used to identify, analyze and report themes within qualitative data. Thematic analysis was selected for this study due to its flexibility which makes it a rigorous approach with a potential to provide rich and detailed data (Braun & Clarke 2006). However, the flexibility of the approach has resulted in "anything goes" critique of the approach and qualitative research in general (Antaki et al. 2002). To avoid this limitation, the researcher used the recommended guidelines in carrying out thematic analysis (Braun & Clarke 2006). In thematic analysis a theme is a pattern found in the information that at a minimum describes and organises the possible observations and at a maximum interprets aspects of the phenomenon (Boyatizis 1998). This thematic approach entailed sifting data from KIIs, FGDs, organisational reports and observations according to pre-defined and emerging themes. Themes in this thesis were from both the field data (an inductive approach), and from the researcher's prior theoretical understanding of the phenomenon under study (deductive approach). The use of the deductive approach was enabled by an extensive literature review which was done before data collection and the use of the SLF as the conceptual framework for the overall investigation (see Chapter Two).

According to Braun & Clarke (2006) data familiarization is the first step in theme analysis. During familiarization audios were listened to, and data was transcribed into a written format and translated into English, verbatim (Thomas 2003). Although there are no guidelines to follow when producing a transcript (Braun & Clarke 2006), the researcher made sure that the transcript maintained its original nature from both the verbal and non-verbal accounts. This was done by translating data while transcribing it. This exercise enabled the researcher to understand the meaning of the data rather than the language (Bazeley 2009). Repeated reading of interview, FGD and observation notes was done for immersion. Reading field notes repeatedly is advised due to its effectiveness in searching for themes (Miles & Huberman 1994). To capture actual responses and actions by respondents based on the triangulation method, direct quotations from the participants were used and these formed an integral part of the analysis.

Reading through the field notes enabled the researcher to code the data. Coding is when data sets were labelled into categories based on the research objectives (Ishakar & Bakar 2012). After coding, data was then grouped into themes. For example, all information related to financial factors of sustainability such as presence of an O&M fund, regularity of making financial contributions, adequacy of funds and rules on fee collection formed one theme. This was done for all the other factors of sustainability which were analysed in objective one (see Chapter One). The themes which were formed to answer objective two included roles and practices of institutions at district level, roles and practices of institutions at community level, and CBM training requirements. Of importance to note is that, although the stages used in the analysis of the data looked sequential, they were very repetitive as they built up on previous stages. As highlighted by Braun & Clarke (2006), "analysis is typically a recursive process, with movement back and forth between different phases". This also helped to refine codes and themes used in the study.

3.7 Pilot study

A pilot study is a mini-version of a full-scale study done in preparation of the main study (Ian & Karen 2007). In the current study a pilot study was conducted in Umzingwane and Zvishavane districts. Districts which were not part of the study were selected because the pilot study may influence the behaviour of research participants during the main study if they would have already been involved in the research (Jariath & Parsons 2000). As stated by De Vos (2002) that the pilot study should take place in a setting which is convenient for the researcher and that resembles the one used for the main study, the selected districts were found to be sharing the same types of water lifting devices and management approaches with the study districts. The two districts were also selected to cater for the local languages (Ndebele and Shona) which are used in the study sites. The pilot study sought to test the research design and the data collection tools; household and WPC questionnaires, KIIs guide, FGD guide as well as observation checklists. The value of the pilot study was therefore to test the feasibility of both research instruments and the research process. Any potential challenges with the research process and tools that could have contributed to the failure of the main research study were identified and addressed. A total of 50 water points and 50 households were randomly selected for the pilot study in each district. One person was interviewed to test the KIIs guide at national level while four people were interviewed to test the same tool at district and ward levels. To test the FGD data collection tool one FGD session was conducted in each district.

The pilot study helped to improve the research design used in the final study. Initially, only one FGD session was scheduled per district, however, the sessions were increased to two per district in the main study. An additional session was considered to cater for community leaders who could not be combined with WPCs, VHWs and VPMs due to power relations. The number of KIIs interviewed at district level was also changed from three to five so as to increase the number of DWSSC participants in the main study. The results from the pilot study also revealed that having FGDs at public places such as business centres, churches and water points attracted more people than the invited participants. To avoid such problems in the main study, FGDs were conducted at schools where the researcher would ask for a classroom from the school authorities. The pilot study was also valuable in identifying unclear questions in the data collection tools. Since the data collection tools were self-designed, a pilot study was necessary to check if the questions were still carrying the same meaning and answering the research questions when asked in local languages. One important correction was how sustainability questions were asked. During the pilot study it was noted that the words which were used for sustainability and functionality in the local languages were similar, hence this was corrected in the final data collection tools. The pilot study was also used to train research assistants in data collection.

Conducting the pilot study also enabled the researcher to target the right participants at national, district, and household levels. For example, the initial targeted respondents at household level were the household heads. However, after the pilot study it was noted that some household heads especially men were unable to respond to some of the survey questions. This was solved by interviewing household members who were responsible for water collection and management who were found to be mainly women and girls. At district level although permission was sought from the heads of government departments, it was learnt during the pilot study that they did not have adequate information to answer the interview questions hence field officers working at district level were targeted in the main study.

3.8 Positionality and reflexivity

Positionality and reflexivity of the researcher were considered in this study because epistemologically, the research philosophy is not rooted in the extremes of subjectivism or positivism. However, it draws most strongly on characteristics of critical realism where reality is defined by both objective and subjective influences (Wetherell 1998). In this regard to ensure the necessary rigour which enhances reliability and validity of the study results, the researcher had to be self-aware, preside over and mitigate the influence or biases her dispositions could have had on the research process and the results. In qualitative research, this has been conceived as reflexivity and it has been noted to be a critical component of qualitative research design (Guillemin & Gillam 2004). According to Chiriseri-Strater (1996) reflexivity connotes 'a continuous process of reflection by the researcher on his/her own values, pre-conceptions, behaviour or presence and those of the research participants which can affect the interpretation of responses'.

With regard to positionality, Stewart (2007) argued that "the researcher should aim to clarify his position in a wider societal hierarchy of power, status and influence, thereby ascertaining the different sorts of relationships that compete with the many differing roles, responsibilities and possible limitations to what can and should be 'exposed' about the researched". Positionality in rural water management studies was found critical because people conceptualize the world and their reactions to researchers in various ways (England 1994).

Power relations between the researcher and the respondents evolved from the researcher being seen as an outsider at the initial stages of the study to being seen as an insider at the later stages. My status as a Shona with the same linguistic background as the participants in Nyanga and Chivi districts made the participants to be reluctant to share their views and opinions. However the situation was different in Gwanda district where the majority of the respondents were Ndebele speaking. Although the researcher was not fluent in their local language her enthusiasm to learn the language and the recruitment of Ndebele speaking interpreters and research assistants motivated the participants to give their full support during fieldwork. In Gwanda District the respondents' stance of viewing the researcher as an outsider was also shifted when the researcher revealed that she is a lecturer at a local university in the Matebeleland region where the district is located.

In all the districts permission was sought from the District Administrators' offices before entry into the field. The researcher introduced herself as a student and a lecturer at a local university in the country who was undertaking purely academic work. This was done to palliate fears that the research was based on political influences or the optimism that the research will bring water development projects. The confirmatory letter of being a lecturer at the National University of Science and Technology (NUST), obtained from the university also enabled KIIs at the national, district and ward levels to provide most of the requested documentation. This is so because the researcher being a government employee like most of the KIIs respondents, they had the confidence to share even some of the confidential information.

3.9 Reliability and validity

The trustworthiness of qualitative research is generally questioned by positivists, perhaps because their concepts of validity and reliability cannot be addressed in the same way in naturalistic work (Cresswell & Garreth 2008). To enhance reliability and validity of the present study the researcher used multiple strategies as recommended by Creswell and Millers (2004). The different methods which were used are triangulation, audit trails, prolonged engagement in the field, debriefing and member checks. Multiple methods were considered to cater for the different views of people who conducted, participated, read or reviewed the study. Triangulation was discussed in Section 3.2; hence only the remaining methods will be discussed below:

3.9.1 Prolonged engagement in the field

Although the administration of questionnaires and conducting of KII and FGD sessions were scheduled for two months per district, the researcher stayed in one district for three months. As contended by Onwuegbuzie (2009) "working with people day in and day out for long periods of time gives ethnographic research its validity and vitality". In this study, prolonged stay in the field resulted in trust being built and rapport being established such that participants became comfortable in disclosing information.

3.9.2 Debriefing

Debriefing was done in three forms. The first one is when the researcher scheduled meetings with her academic supervisors. Such meetings gave an insight on the best research design to be used, appropriate sample sizes as well as data analysis methods to be considered in the study. Debriefing was also done with professional colleagues with experience in rural water management. Their professional critiques were valuable in improving the research design/data collection procedures, data analysis procedures, and interpretations as they challenged the researcher's assumptions (Spall 1998). Presenting part of the study at international conferences also challenged the researcher's assumptions, whose closeness to the project could have inhibited her ability to view it with real detachment. The fresh perspectives brought by conference participants could not be overlooked in improving the validity of this study. Prolonged stays in the field also enabled the researcher to do debriefing with participants. The researcher managed to have reflective dialogues with participants after FGDs and KIIs sessions to gain a more accurate and detailed understanding of participants' perceptions. The last debriefing exercise was done with session moderators and note-takers to verify the accuracy of data collected.

3.9.3 Member checks

The researcher moderated the FGD as well as KII sessions. To verify the accuracy in interpreting participants' viewpoints, meanings attached to words and actions, and feelings regarding factors perceived to influence sustainability, the moderator would comment to confirm the participant's views. An example of such comments which were used to confirm results of the study is "Inadequate financial contributions is a challenge at most water points, is that right?" Group consensus over a point was then viewed as a verification of the accuracy of the viewpoint. KIIs participants were also asked to read transcripts of dialogues in which they would have participated. The emphasis of such exercises was for the informants to check and confirm if their words match what they actually intended.

3.9.4 Audit trails

The researcher kept all documentation on the research decisions, activities and results. This enabled the researcher to make constant comparisons of significant study procedures, codes and emerging themes during data analysis. The audit trail also served as a support to each finding, where the evidence can be found and how the evidence was interpreted in the study.

3.10 Ethical issues

Any research endeavour that involves human subjects needs to take into account ethical issues that might potentially impact those individuals under study. Gibson and Brown (2009) argued that researchers need to give consideration of ethical issues because they impact on the entire research design hence the quality of their research. However, some researchers attend to ethical issues only because research boards expect them to do so (De Vos et al. 2005). Punch (1994) quote Webster's New World Dictionary which defines ethical as conforming to the standards of conduct of a given profession or group. In addition, De Vos et. al. (2005) define ethics as a set of moral principles which is suggested by an individual or group, is subsequently widely accepted, and which offers rules and behavioural expectations about the most correct conduct towards experimental subjects and respondents, employers, sponsors, other researchers, assistants and students. Ethical guidelines also serve as standards, and a basis upon which each researcher ought to evaluate his own conduct. Official permission to undertake this study was sought from the University of Western Cape's Ethics Committee. The anticipated potential for harm to individuals was minimal.

Prior to data collection study participants received full verbal explanations about the aims and objectives of the study and informed consent and assent were obtained. The questionnaires, FGDs and KIIs were conducted in Shona and Ndebele which are the local languages in the studied districts. However, communication was in the language a participant feels most comfortable in. Participants were also informed that participation in the research was voluntary such that if at any time during the interviews participants felt they no-longer want to continue with the interview they were free to inform the interviewer who would stop the interview at that moment. However, to increase the opportunity for full participation the researcher greatly emphasized on the importance of the communities' contribution in the present study due to its potential in influencing policy in rural water development.

Confidentiality was preserved in that only the researcher and her assistants had access to the data and only group results were reported on. Interview results were only shared with the interview participants. Electronic data was held on password-protected computers and a password-protected online backup site. The survey did not collect information that could be used to identify participants as individuals or households. The researcher also sought permission to use the camera and video tape before data collection sessions started for transparency. This also served as a way of enhancing participant confidence in sharing views and opinions.

Another ethical issue in this study was that the study involved children in child-headed families as participants. Research involving children and youth raise unique ethical issues. These are as a result of issues of competence, autonomy and vulnerability of children. Now, there are three widely accepted models of consent for children and youth (minors). First, children who are considered competent may provide consent on their own. Second, some children may provide an assent with parental consent. Third, some children, due to their age or developmental stage, cannot provide consent and parental consent is sought. In this study only competent children who could provide consent on their own, with advice from their guardians, participated in the survey.

3.11 Summary

The main aim of the chapter was to demonstrate how the study research questions were answered. The description of the study area at both national and district levels showed that the main sources of income are agriculture-based. Main water supply providers were NGOs and the main water sources are boreholes and wells.

The discussion on research design presented the most common research designs used in water management studies. Given the research questions of the current study, the case study research design combined with the cross-sectional research design was used. Since the use of the case study research design combined with the cross-sectional design requires the use of multiple data collection methods, the researcher settled for the mixed methods approach over the purely qualitative or quantitative approaches. Among the various mixed method designs, the concurrent triangulation method was selected due to its ability to confirm, cross-validate and corroborate findings within a single study.

Different sampling techniques were used to select participants at national, district, ward as well as household levels. The study used probability sampling techniques to enable statistical inferences of the results to be made. Non-probability sampling techniques were used to select participants based on theoretical reasons. The selection of data collection methods was based on the type of data to be collected as well as its source. Both qualitative and quantitative data collection methods were used to satisfy the requirements of the chosen research approach (mixed methods approach). The methods used in the study are questionnaires, KIIs, FGDs, document analysis, observations and participatory research techniques.

The type of data collected and the specific research question to be answered guided the researcher in the selection of the data analysis to be performed. MCA using the AHP method was used to determine the relative importance of factors by assigning weights to the studied sustainability factors. For the determination of key influential factors of sustainability, exploratory factor analysis using the principal-axis factoring method was done. T- tests were done to compare the performance means of sustainability variables. The independent samples t-test was used to compare the means of sustainability variables for the control group and experimental group. On the other hand, paired samples t-test was used to detect changes in factor performance before and after the implementation of gardens at water points.

Qualitative data was analyzed through thematic analysis. Steps for performing the analysis as recommended by various authors were recognized and followed for validity of the study findings. Data from qualitative analysis was triangulated with data from quantitative analysis to answer the why questions of the study so as to have a full understanding of the phenomenon under study.

The discussion on the pilot study which was undertaken before the main study clearly revealed the significance of the exercise. As a result of the pilot study, data collection tools and the research design in general were improved. Identifying gaps and problems of the research strategy before conducting the main study assisted in reducing the risk of failure during the main study. Reliability and validity of the study were improved through triangulation, prolonged engagement in the field, member checks, debriefing and disconfirming evidence. Finally the chapter gave the ethical issues which were considered by the researcher to protect the interest of the respondents, research assistants as well as the researcher. The next chapter will present the results on the first objective.

4 FACTORS INFLUENCING SUSTAINABILITY OF COMMUNALLY-MANAGED WATER SUPPLY SYSTEMS IN ZIMBABWE

4.1 Introduction

Accessing water for various uses (domestic, industrial, agricultural and environmental) has been a global development challenge. Although the magnitude of the challenge varies from one region to another and from one country to another, developing countries in Africa and Asia are the most affected (WHO/UNICEF 2015). In an effort to address the global water challenges, a number of conferences have been held and declarations have been made. These conferences include the United Nations Conference on the Human Environment held in Stockholm in 1972 (United Nations 1992), followed by the United Nations Water Conference (UNWC) in Mar del Plata, Argentina in 1977 (United Nations 1977), and the International Conference on Water and the Environment (ICWE) in Dublin, 1992 (United Nations 1992). The Dublin conference resulted in the famous Dublin Statement, in which the, management of global freshwater resources became a key development question of the 21st Century. The main outcome of the conference was four guiding principles which embrace issues of governance and sustainability. These principles are: (i) fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment (ii) water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels (iii) women play a central part in the provision, management and safeguarding of water, and (iv) water has an economic value in all its competing uses and should be recognized as an economic good (United Nations 1992).

Other conferences that have been held include the Water Supply and Sanitation Collaborative Council's Global Water forums and the United Nation's (UN) Earth Summits. These conferences and declarations such as the International Drinking Water Supply and Sanitation Decade (IDWSSD) between 1980 and 1990 (United Nations 1980) and the United Nations Water for Life Decade 2005-2015 (United Nations 2006) led to a shift in water provision and management (Spaling et al. 2014). The shift stressed the importance of the approaches that deepened community participation in the management of water and sanitation infrastructure (Moriarty et al. 2013). Approaches that promote community participation in water development and management have been advocated to achieve sustainability of water supply systems (Quin et al. 2011). Furthermore, the global efforts to promote sustainability of water supply were shown in September 2015, when the UN General Assembly agreed to a stand-alone goal focusing on water and sustainability in its SDGs as discussed in Chapter One (United Nations 2015). This shows that where water systems would have been installed, they need to be sustained. The factors that influence sustainability have to be known for appropriate solutions to be developed. Following guiding principles of the conferences and declarations highlighted above may not yield the intended outcome when factors that influence sustainability in local contexts are not known.

Sustainability of water supply systems is influenced by a number of factors which have been discussed in many rural water supply service discourses. Authors who have discussed these factors include Montgomery et al. (2009), Smith (2011), Quin et al. (2011), Silva et al. (2012), Tadesse (2013), Spaling et al. (2014) and Alexander et al. (2015). These factors were discussed in Chapter Two and broadly they have been classified as economic/financial, social, institutional, technical and environmental (Whittington et al. 2009; Montgomery et al. 2009; Spaling et al. 2014) (see Section 2.1). A number of sub-factors have been identified under each factor. Different authors have used varying combinations of these factors when assessing sustainability. Authors who have considered several factors argue that sustainability is a complex issue and should be assessed in a holistic approach (Carter & Howsam 1999; Harvey & Reed 2004; Amjad et al. 2015). However, little attention has been afforded to investigate how different factors relate to each other in contributing towards sustainability. Understanding such relationships is crucial in promoting sustainability of water supply facilities. Another knowledge gap that exists in literature is on the key influential factors of sustainability in different localities since these factors are context specific (Marks et al. 2014). Peter & Nkambule (2012) concluded that technical and social factors were of great importance in influencing sustainability of water supply systems in Swaziland. Opare (2011) noted that external support in training local institutions in management, technical skills as well as monitoring enhanced sustainability of water supply systems. On the contrary economic and institutional factors were noted to be of great importance by Hoko et al. (2009). In resource constrained countries, key influential factors should therefore be known for prioritization of interventions.

With the gaps identified in the foregoing discussion, this chapter seeks to answer the following questions:

- What is the sustainability status of water points in the studied districts?
- Which factors influence sustainability of water supply systems in rural areas of Zimbabwe?
- Which are the key influential factors of sustainability in Zimbabwe?

Answering these questions at a national level will help to incorporate the key influential factors of sustainability at different stages of project development. This will contribute towards achieving the set SDG (6) relating to provision of sustainable water systems. Limited understanding of key influential factors at local level suggests limited impacts of some commonly adopted project elements in different contexts.

4.2 Water source types used in the study area

A total of 399 water points out of the targeted 459 were assessed for sustainability in the three districts. The other 60 water points could not be studied due to unavailability of data. The numbers of targeted and studied water points per district are shown in Table 4.1.

Table 4.1: Number of targeted and studied water points per district

District	**Number of targeted water points**	**Number of studied water points**
Chivi	131	107
Gwanda	194	177
Nyanga	134	115
Total	**459**	**399**

The types of water sources found in the study area are boreholes, deep wells, shallow wells, springs and sand abstraction sites. Results show that boreholes, shallow wells and deep wells were common in all districts. However, springs were only found in Nyanga District while sand abstraction sites were only found in Gwanda District (Table 4.2).

Table 4.2 Water source types used in the study area

District	Water source types				
	Boreholes	**Deep wells**	**Shallow wells**	**Sand abstraction sites**	**Springs**
Gwanda	50.7%	15.4%	3.4%	30.5%	0%
Chivi	76.6%	16.0%	7.3%	0%	0%
Nyanga	62.6%	21.3%	13.5%	0%	1.7%
Average	63.3%	17.6%	8.0%	10.2%	0.6%

Boreholes constituted the highest percentage (63.3%) of water sources in all the districts (Table 4.2). The dominance of boreholes across the districts is attributed to the IRWSSP which was implemented in Zimbabwe in the 1980s (Section 1.5). Nyanga District is the only district with springs due to its mountainous topography. On the other hand, Gwanda District is the only district with sand abstraction sites (30.5%) as it utilizes the silted rivers which are found in the semi-arid region. Chi square test results (χ^2 =151.4, df=10, p<0.01) indicate that there is a significant difference in water source types across the three districts.

4.3 Types of water lifting devices used in the study area

The types of water lifting devices used in the study area which were studied are bush pumps, elephant pumps, rower pumps and windlass (Figure 4.1).

Bush pump

Windlass

Elephant pump

Rower pump

Figure 4.1: Types of water lifting devices used in the study area

The presence of these water lifting devices varied from one district to another (Table 4.3).

Table 4.3 Percentages of water lifting devices per district

Lifting device	**District**		
	Chivi (%)	**Gwanda (%)**	**Nyanga (%)**
Bush pump	68	57	91
Windlass	5	11	9
Elephant pump	27	0	0
Rower pump	0	32	0

Bush pumps were found across all the three districts. The pump was adopted as the National Standard Hand Pump in the 1980s by the Zimbabwean government (Morgan et al. 2002). The bush pump can be fitted on wells and boreholes, and its high prevalence was due to the IRWSSP which installed the water lifting device on most communally-managed systems which were developed under the programme (Section 1.5).

The windlass was used on both hand dug and drilled wells. Although the windlass was found across the three districts, its dominance was on water points which are individually owned and managed. This was because the lifting device was considered to be affordable to install by 88% of the interviewed individual households as compared to bush pumps. The windlass was also dominant at household level as it was promoted under the Upgraded Family Well programme which was launched by the government of Zimbabwe in 1988 (Robinson 2002).

Elephant pumps which are simple rope and washer pumps with an elephant shaped superstructure were only found in Chivi District. The pumps were installed by Pump Aid Zimbabwe a local NGO during the early 2000s. The rower pump is another water lifting device which was not common in the study area as it was only found in Gwanda District. The pump is a simple lifting device that is used to pump water from the river bed and it was installed by a local NGO called Dabane Trust. The presence of the rower pumps and the elephant pumps in Gwanda and Chivi districts respectively is attributed to the nature of NGO projects under which they were implemented. Chi square test results (χ^2 =214.2, df=8, p<0.01) indicate that there is a significant difference in water lifting devices used across the three districts.

4.4 Sustainability assessment

Sustainability assessment was done by first assigning weights to all factors and sub-factors. This was done using pairwise matrices under the AHP as explained in Section 3.5.1. The weight of each factor shows its relative importance in contributing towards sustainability. The AHP results are presented in the next section.

4.4.1 Sustainability weights of factors

Results from the AHP showed that the importance of sustainability factors and sub-factors varied from one district to another (Figures 4.2 to 4.4). According to the judgment and experiences of field professionals in the study area, institutional factors were considered to be the most critical in all the three districts, although the assigned weights differed from one district to another. Nyanga had a weight of 0.55 while Gwanda had 0.5 and Chivi had 0.42. Institutional sub-factors that were found to be critical in the three districts are functionality of water user committees and training of user communities in CBM. Technical factors were noted to be second in importance in Gwanda District with a weight of 0.22. However, in Nyanga District financial factors were considered to be second in importance with a weight of 0.13 while in Chivi District environmental factors with a weight of 0.2 were considered to be second in importance. Environmental factors were considered to be of least significance in influencing sustainability as compared to the other four factors in Gwanda and Nyanga districts with weights of 0.09 and 0.08 respectively. Reliability of water supply was noted to be a key sub-factor in both districts under environmental factors. In Chivi, District the factor that was assigned the least weight was social (0.09). The sub factor under social which was considered to be critical is community participation in planning with a weight of 0.04 while conflict management was considered to be the least with a weight of 0.01.

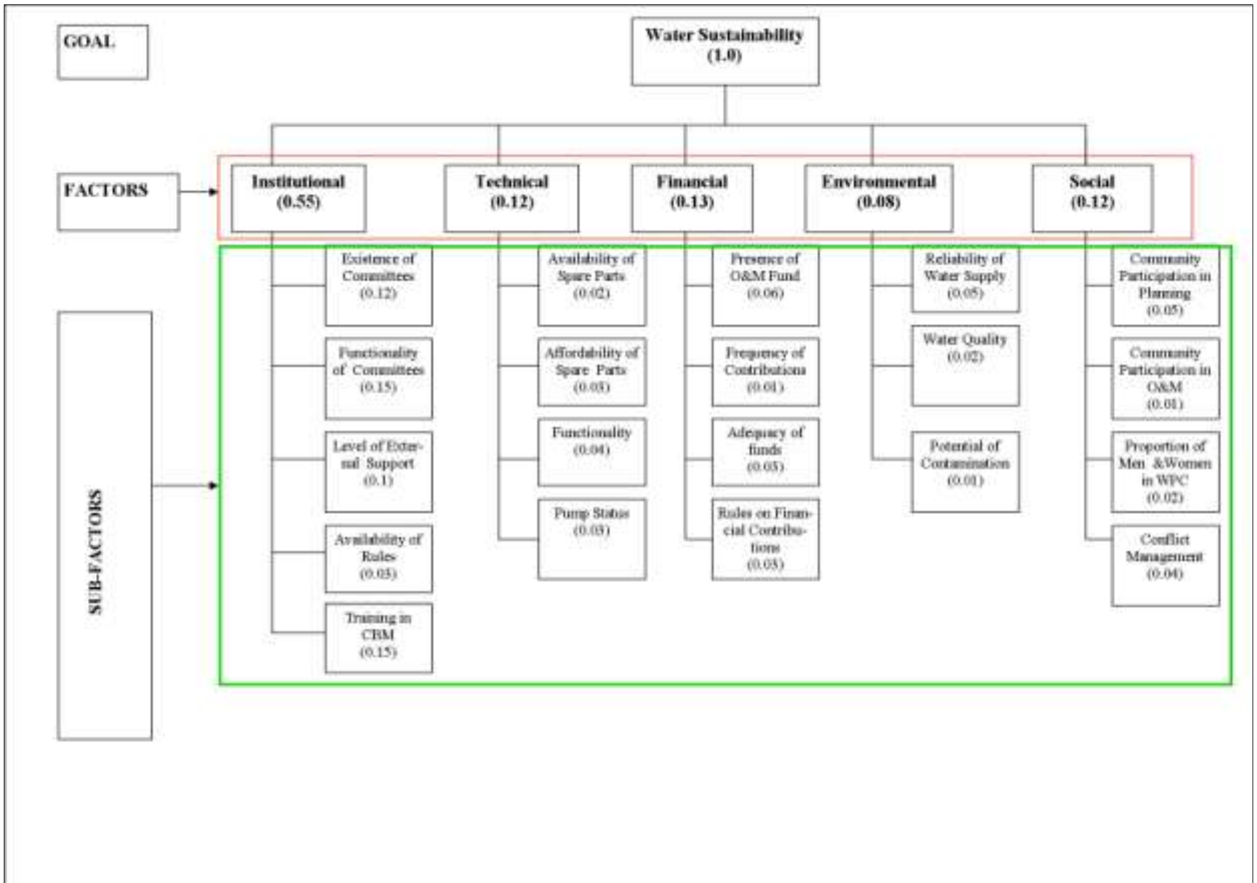

Figure 4.2: Weights of factors and sub-factors assigned in Nyanga District

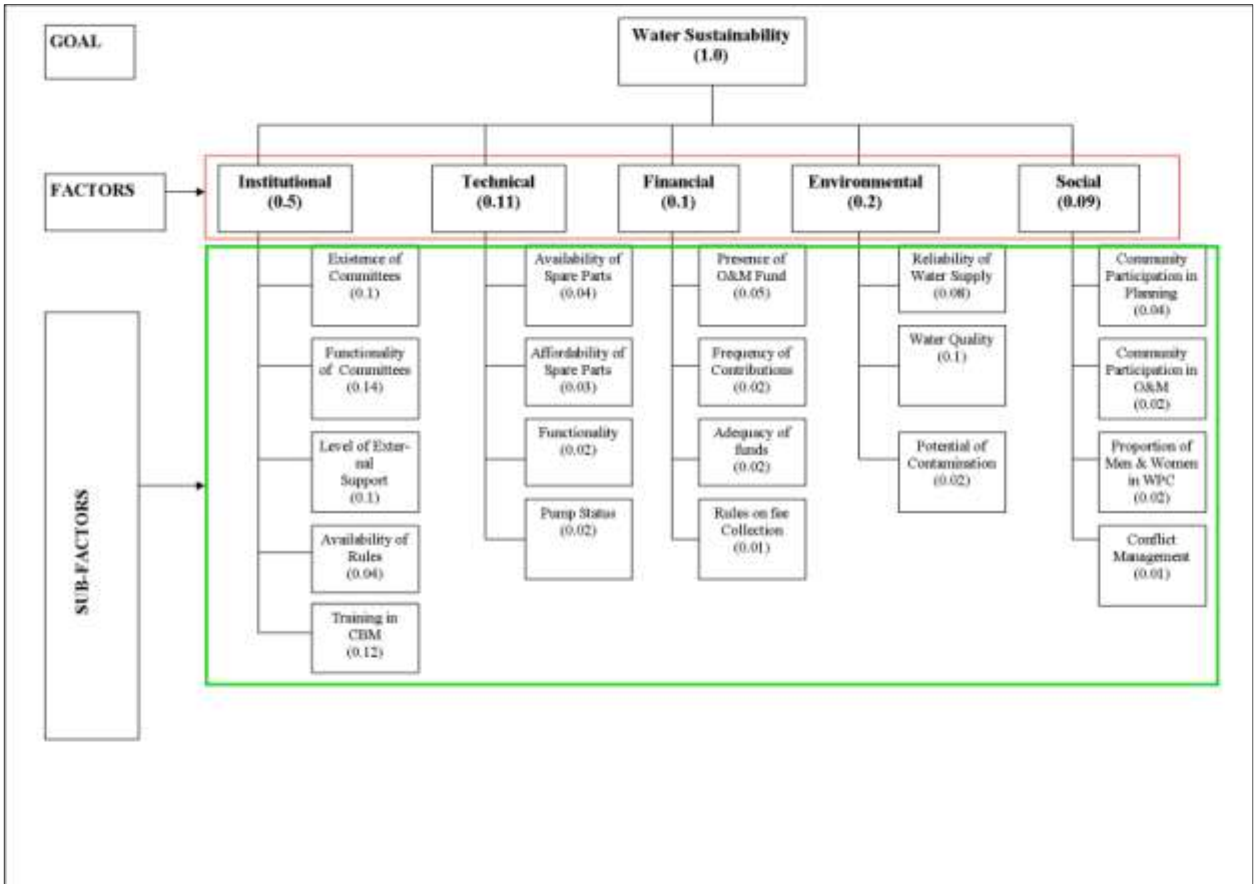

Figure 4.3: Weights of factors and sub-factors assigned in Chivi District

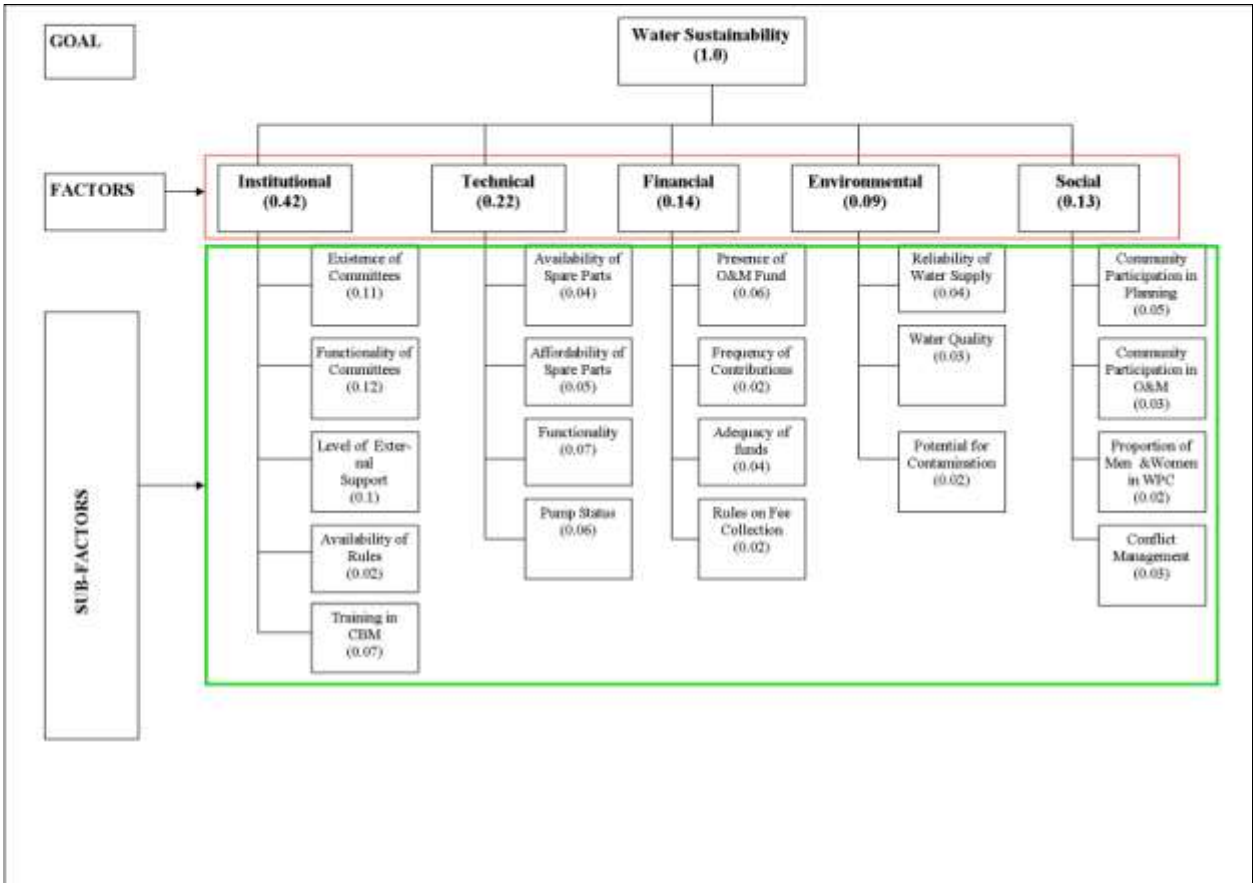

Figure 4.4: Weights of factors and sub-factors assigned in Gwanda District

After assigning weights to all factors and sub-factors, the next step was to investigate the performance of the water points in the field. Performance scoring was done on the factors and sub-factors presented in Table 3.4.

4.4.2 Performance scoring

Performance scores of each sub-factor were obtained based upon the principle that 1 represents a positive contribution towards a sub-factor and 0 represents no contribution (Section 3.5.2.). Field surveys were used to obtain scoring data where a series of questions were asked on each sub-factor (example in Table 3.7). The performance score of a factor is the summation of all sub-factor scores under a specific factor and it is expressed as a percentage. The mean, maximum and minimum scores for each factor per district are presented in Table 4.4.

Table 4.4: Summary of performance scores (%) per factor

	Institutional			Financial			Environmental			Social			Technical		
	Nyanga	Gwanda	*Chivi*	Nyanga	Gwanda	Chivi	Nyanga	Gwanda	Chivi	Nyanga	Gwanda	Chivi	Nyanga	Gwanda	Chivi
Mean	50.8	70.5	59.2	33.5	43.5	52.1	65.3	59.2	58.2	41.3	74.7	67.1	50.5	70.9	60.1
S.D	44.62	50.72	31.26	24.47	34.06	22.33	42.43	32.77	34.19	22.38	52.95	44.71	38.27	54.61	42.70
Min	18.2	23.8	20.0	7.9	7.4	10.0	12.5	22.0	5.0	8.3	38.6	44.4	16.0	36.6	27.7
Max	94.0	95.2	88.0	84.1	92.5	90.0	75.0	88.0	90.0	83.1	92.3	88.6	83.3	95.5	81.8

Sample sizes (N): Nyanga = 115

Gwanda = 177

Chivi = 107

Table 4.4 shows that water points in Gwanda District had the highest average performance scores in institutional, social and technical factors with scores of 70.5; 74.07 and 70.09 respectively. On the other hand, Chivi District had the highest mean performance score (52.1) in financial factors while Nyanga dominated in the environmental factors with a mean score of 65.38. Generally all the districts had high scores in the institutional factors which were mainly attributed to the presence of WPCs at most water points. Water points in Gwanda dominated in technical factors due to availability of spare parts at community level. Notably, financial performance across the districts was generally poor with the highest score of 52.1 which was recorded in Chivi District. Poor financial performance was mainly due to the absence of O&M funds and irregularity of making financial contributions as will be discussed in Section 4.5.

4.4.3 Sustainability scores per district

Sustainability scores were calculated by multiplying the sub-factor weights (Figure 4.2-4.4) by the performance scores presented in the previous section (see Section 3.5.2). The sustainability score for each factor was the summation of all sub-factor scores for that factor. The scores are expressed as a percentage and they are presented in Table 4.5. Chivi District had the highest (35.12%) institutional sustainability mean scores as compared to Gwanda (29.61%) and Nyanga (27.82%). Chivi District also had the highest mean score (11.7%) for environmental factors while Nyanga had 4.43% and Gwanda had 5.33%. Water points in Gwanda performed best in financial (6.09%), social (11.63%) and technical (15.42%) factors as compared to the other two districts.

The overall sustainability score for a water point was then calculated by summing up the factor scores of that water point. These scores were used to classify water points using the classification presented in Table 3.8. Results on sustainability classification are presented in Section 4.4.4.

Table 4.5: Summary of sustainability scores (%) per factor

	Institutional			**Financial**			**Environmental**			**Social**			**Technical**		
	Nyanga	Gwanda	Chivi	Nyanga	Gwanda	Chivi	Nyanga	Gwanda	Chivi	Nyanga	Gwanda	Chivi	Nyanga	Gwanda	Chivi
Mean	27.8	29.6	35.1	4.4	6.1	3.2	4.4	5.3	11.7	8.0	11.6	8.1	6.0	15.4	6.7
S.D	14.46	10.38	11.26	3.42	4.86	2.37	2.61	2.36	4.66	2.69	2.68	1.71	2.37	4.06	2.14
Min	10.0	10.0	10.0	1.0	1.0	1.0	0.0	2.0	0.0	1.0	5.0	4.0	2.0	8.0	3.0
Max	52.0	43.0	44.0	17.0	14.0	10.0	8.0	9.0	20.0	12.0	14.0	9.0	14.0	21.0	11.0

Sample sizes (N): Nyanga = 115

Gwanda = 177

Chivi = 107

4.4.4 Sustainability classification by district

As explained in Section 3.5.2, water points with a sustainability score which was below 25% were classified as not sustainable, 25-49% partially sustainable, 50-74% sustainable and 75% and above highly sustainable. Based on this classification, 33% of the water points were in the partially sustainable and not sustainable categories. Notably, Gwanda District had the highest proportion (74%) of water points which were sustainable and highly sustainable. On the other hand, Nyanga District recorded the highest proportion of water points which were partially sustainable and not sustainable (48%). In Chivi District, 37% of the water points were partially sustainable and not sustainable (Figure 4.5).

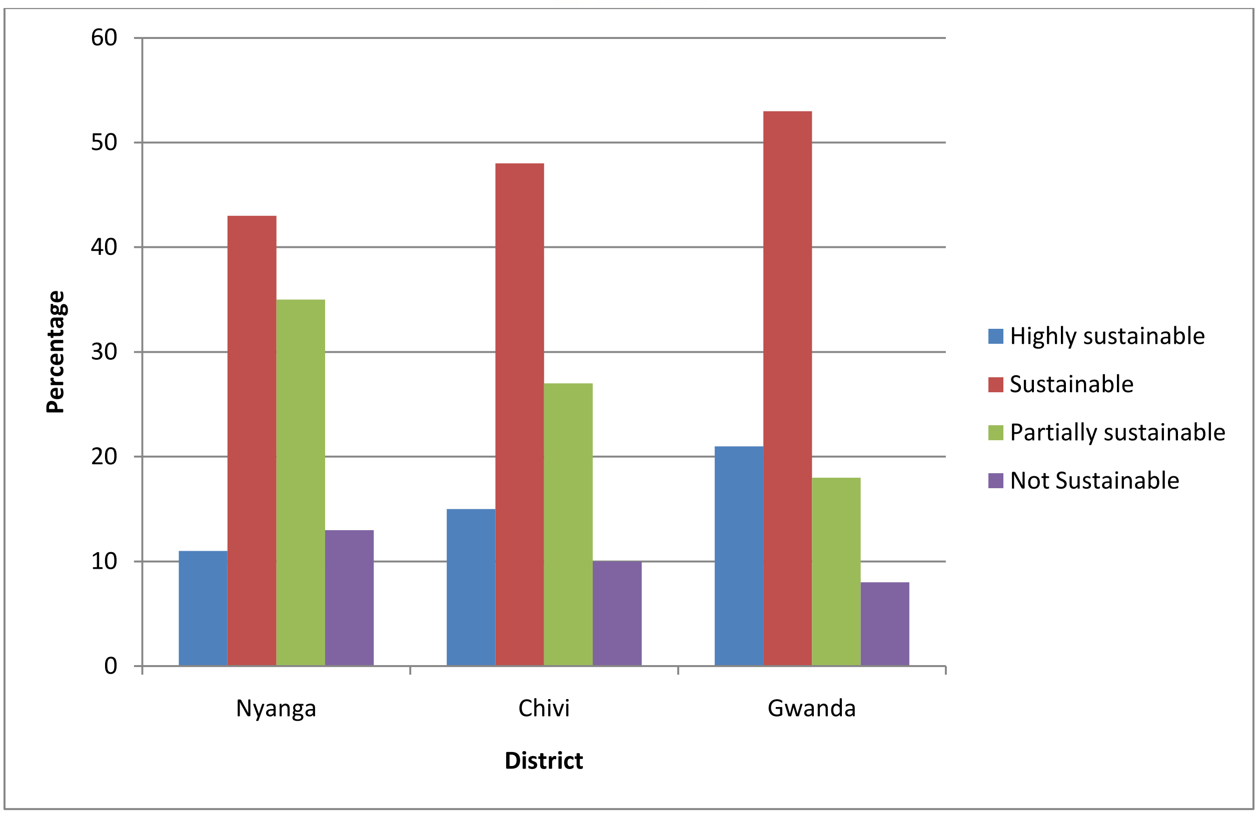

Figure 4.5: Sustainability classification by district

Chi square test results show that sustainability of water points differed significantly across the three districts (χ^2=73.59, df=4, p<0.01). These differences exist because factors which affect sustainability are context-specific, and this is what the literature on factors of sustainability suggests as discussed in Chapter Two. Sustainability classes were also not uniform across the wards in the three districts (Table 4.6).

Table 4.6: Sustainability scores and classification per ward

District name	Ward number	Ward average score (%)	Sustainability classify
Nyanga	2	51.1	Sustainable
	15	40.7	Partially Sustainable
	22	54.7	Sustainable
	23	62.4	Sustainable
Gwanda	3	58.0	Sustainable
	7	76.9	Highly Sustainable
	13	75.0	Highly Sustainable
	17	61.6	Sustainable
Chivi	2	72.0	Sustainable
	10	69.0	Sustainable
	16	58.5	Sustainable
	22	41.4	Partially Sustainable

Most (66%) of the wards were in the sustainable category. Chivi and Nyanga districts had one ward each in the partially sustainable class, while Gwanda District did not have a ward in this class. Instead, Gwanda District was the only district with two wards in the highly sustainable class. Of importance to note is that, the wards which were in the partially sustainable class had low scores (40.7% and 41.4%) which may likely drop into the unsustainable category. The differences in sustainability performance within districts were attributed to the presence of NGOs in certain wards within a district. Wards which had NGOs operating in them tend to perform better in institutional and technical factors than those which did not have.

4.4.5 Sustainability classification by water source type

Sand abstraction sites were superior with highly sustainable and sustainable water points (Figure 4.6). They accounted for 76.0% of water points that were highly sustainable and they did not have water points in the not sustainable class. The high performance of the sand abstraction sites was due to the type of lifting device (rower pump) which was fitted on the water source. Rower pumps were sustainable mainly due to the availability of spare parts for the water lifting device at community level.

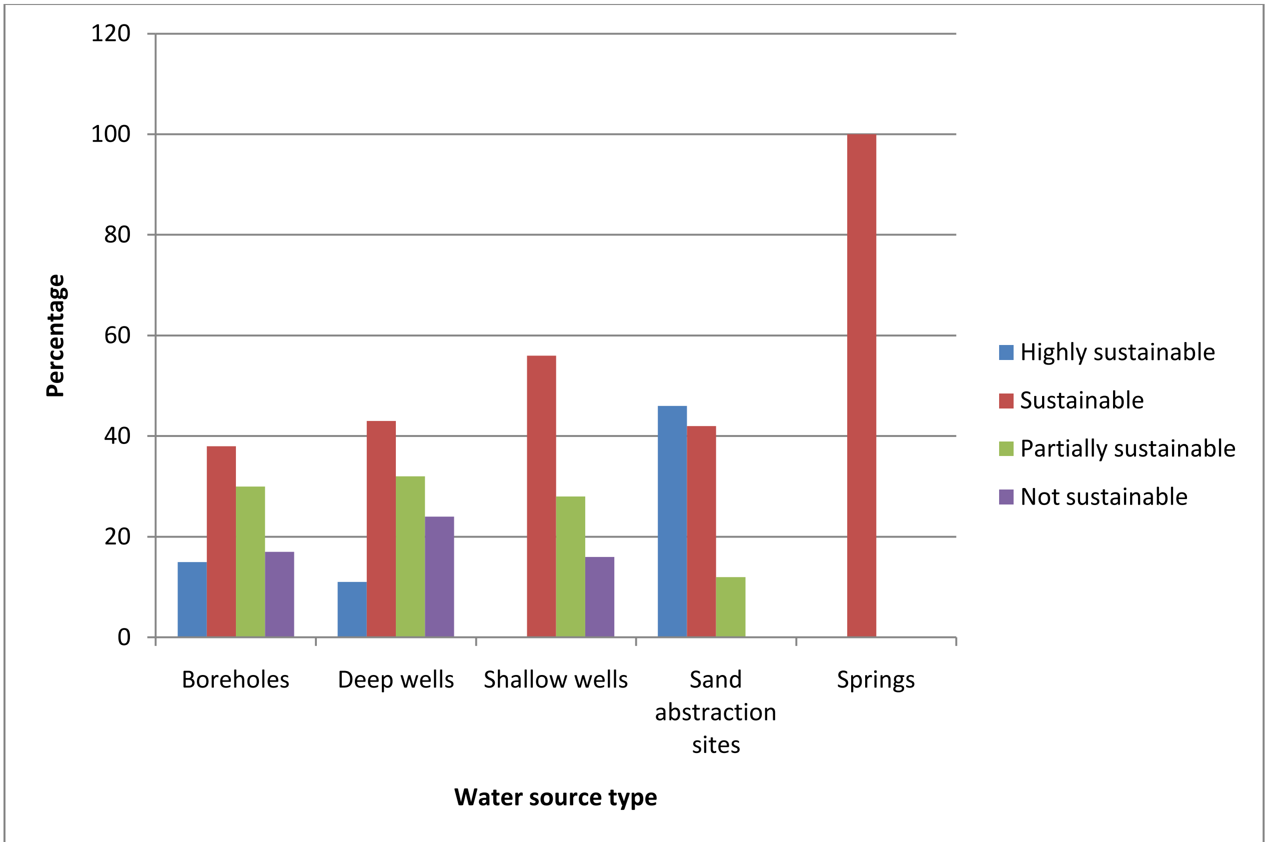

Figure 4.6: Sustainability classification by water source type

Springs and shallow wells did not have water points in the highly sustainable class. The low reliability of water supply during the dry season for all the studied springs and shallow wells resulted in the water sources scoring low sustainability scores. Statistically, sustainability differed significantly with water source type (χ^2=66.55, df=10, p<0.01). This shows that, the type of water sources used had an impact on sustainability in the study area.

4.5 Established factors that influence sustainability in the study area

The factors of sustainability which were studied are technical, social, institutional, environmental and financial. These factors are discussed in the following sections.

4.5.1 Technical factors

The technical factors which were used to assess sustainability are type of water lifting device/technology, availability and affordability of spare parts, functionality of water points and pump status.

Type of water lifting device

Results show that different water lifting devices had varying sustainability scores. The mean values of the scores ranged between 48.03% for elephant pumps to 75.30% for the rower pumps (Table 4.7).

Table 4.7: Mean sustainability scores (%) by water lifting device

Lifting device	Mean	N	Std. Deviation
Bush pumps	57.96	291	15.26
Elephant pumps	48.03	32	12.06
Rower pumps	75.30	57	13.58
Windlass	66.39	19	13.84
Total	61.67	399	18.16

The ANOVA results show that there is a significant difference in the mean overall scores of sustainability for each lifting device. This result indicates that the type of water lifting device significantly influences sustainability ($F=37.4$, $p< 0.01$).

The distribution of the lifting devices among the sustainability classes is shown in Figure 4.7. Sustainability classification by water lifting device was done since mean sustainability scores did not give a full picture on how lifting devices were distributed among the different sustainability categories. Results show that bush pumps, windlass and elephant pumps recorded water points in all the four sustainability categories while the rower pump had its water points distributed in the highly sustainable, sustainable and partially sustainable categories.

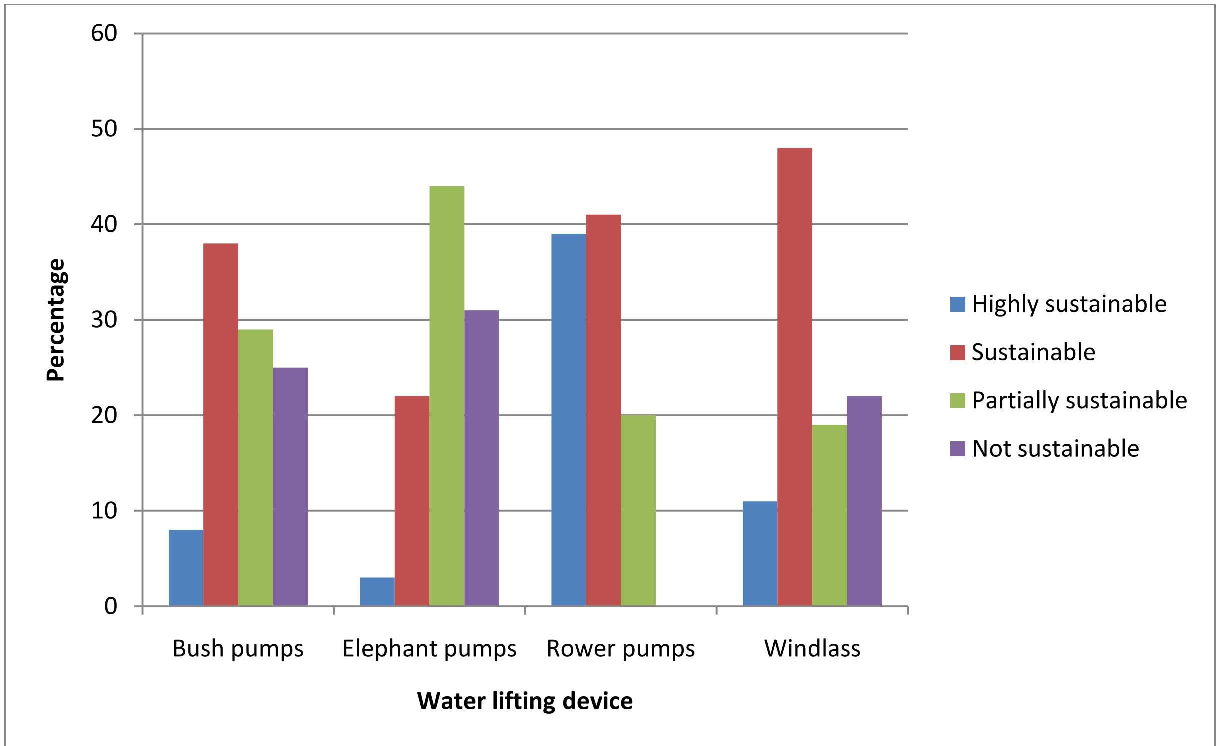

Figure 4.7: Sustainability classification by water lifting device

These results show that the rower pump is the most viable water lifting device in achieving sustainability with no pumps recorded in the not sustainable category. The lifting device had 80% of its water points in the sustainable and highly sustainable classes indicating its impact on promoting sustainability. The least sustainable water lifting device was the elephant pump which dominated (75%) in the partially sustainable and not sustainable categories. Bush pumps which are the most common water lifting device in the study area recorded 52% partially sustainable and not sustainable water points. The distribution pattern in Figure 4.7 shows that, sustainability is a challenge in the study area as most water points across the lifting devices are dominating the not sustainable and partially sustainable categories. Statistically, sustainability differed significantly with type of water lifting device (χ^2=90.48, df=8, p<0.01). Although the type of lifting device does not influence sustainability alone, it is an important explanatory variable.

Functionality of water points

Across the three districts 41% of the water points were not functioning. Nyanga District recorded the highest percentage (43%) of non-functional water points while Chivi and Gwanda recorded 40% each. High percentages of non-functional water points negatively impact on water availability. The chi square test results (χ^2 =0.277, df=2, p=0.871) show that functionality did not vary significantly across the districts. However, further statistical analysis showed that functionality differed significantly with type of lifting device (χ^2 =0.654, df=2, p<0.01). Elephant pumps had the highest percentage (59%) of non-functional water points while bush pumps had 32% and rower pumps had 11%. Differences in functionality across water lifting devices were attributed to the unavailability of spare parts at local level and the cost of repairing the lifting devices in question.

The average downtime (the period between the breakdown date and the date of repair) of water points ranged from days to more than six months across the districts (Table 4.8).

Table 4.8: Average downtime per district

District	Less than 3 days	3-7 days	1-4 weeks	1-2 month	2-3 months	3-6 months	More than 6 months	Total
Gwanda	7%	20%	5%	10.2%	31%	22%	5%	**100%**
Chivi	0%	0%	10%	17%	39%	8%	26%	**100%**
Nyanga	0%	0%	7%	24%	36%	16%	17%	**100%**

Most water points in all the districts had an average downtime of 2 months which is above the 2 days (48hours) recommended downtime for sustainable water points (Dayal et al. 2000; GoZ, 2013). Elephant pumps were the water lifting device that took long to be repaired after a breakdown. Most (42%) of the elephant pumps had a downtime of over 6 months. The main reasons for long downtime for elephant pumps were the unavailability of spare parts at local level (ward and district) and inadequate water supply at water points fitted with the lifting device. Long downtimes resulted in some water points being vandalized where it was reported in 16% of the studied cases. Results show that, six elephant pumps which were vandalized were neglected as communities cited high repair costs since major parts were stolen. Such practices have negative impact on sustainability.

The only water lifting device that had water points (7%) with an average downtime of 2 days is the rower pump. The rower pump was outstanding with 20% of its water points having an average downtime of 3-7 days. The availability of spare parts for the rower pump at community level was the major contributory factor to the shorter downtime for the lifting device as compared to the other devices. The Chi square test results ($\chi^2 = 134.6$, df=16, $p<0.01$) show that down time varies significantly across the districts. Downtime periods were also statistically different across water lifting devices with chi square test results being ($\chi^2 = 113.2$, df=15, $p<0.01$). This result shows the impact of type of lifting device on the sustainability.

FGDs results showed that some lifting devices were considered to be difficult to use in 56% of the sessions which were conducted. Ease of use was in relation to the muscular power required to draw water. Generally, elephant pumps and rower pumps were considered to be easier to use than bush pumps. In Gwanda District, it was observed that, women and children preferred the rower pumps to bush pumps since the rower pumps were considered to be light to use as they can be operated when one is sitting down. Since power availability to draw water depends on an individual's age, state of health and sometimes weight, the rower pump was found to be easy to use by children, the elderly and pregnant women. The lifting device was also preferred since it can be used by the physically-challenged although this depended on the nature of disability.

Ease of use for bush pumps was established using the number of strokes required for water to be discharged. The number of strokes for the water lifting device across the districts ranged from less than 4 to above 45 (Figure 4.8).

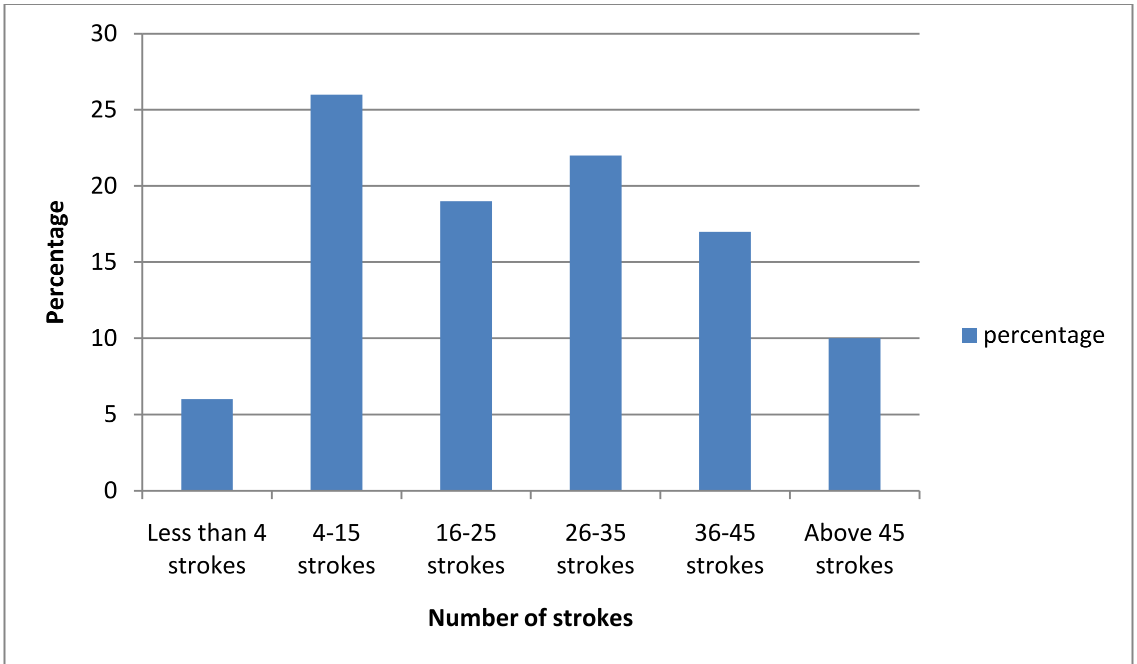

Figure 4.8: Number of strokes required for water to be discharged

A maximum of 4 strokes is generally acceptable in Zimbabwe (Hoko & Hertle 2006). However, only 6% of the water points had strokes less than 4. Although strokes more than 4 are not acceptable according to the Zimbabwean standards, communities never complained about water points that required less than 25 strokes. Instead, complaints were raised for water points that required more than 25 strokes and these constituted 49% of the studied bush pumps. In such cases respondents perceived water points fitted with bush pumps to be difficult to use especially by children and the elderly. It was learnt that, where villages had rower pumps and bush pumps, maintenance and repair preferences were on the former resulting in long downtimes for the latter.

Spare parts availability and affordability

In theory, communities are supposed to get major spare parts for their lifting devices from the Rural District Councils (RDCs), through the District Revolving Funds (DRFs) (NAC 2005). This is part of government's external support to the communities under CBM. However, field evidence showed a different practice where the RDCs did not have the DRFs. The RDCs had some spare parts for bush pumps only while no spare parts were found for the other lifting devices. According to 80% of the RDC personnel, spare parts which they had were donated by

NGOs. Thus, the type and quantity of spares available depended on the nature of NGO projects implemented in their districts and the amount of extra spare parts the implementing organizations will be having. Spare parts which were found in all the districts were only pipes resulting in communities buying other spare parts such as bolts and leather cups from private dealers in their provincial towns. Cylinders for bush pumps were only bought in Harare, the capital city of Zimbabwe, since there were no suppliers of the spare part at district and provincial level. Communities complained of buying spare parts from private dealers who sometimes supplied sub-standard parts which resulted in frequent breakdowns. Furthermore, spare parts supplied by private dealers were sometimes not standard and not compatible with the bush pumps. Unavailability of spare parts for bush pumps at community level was contributing to long downtimes of the lifting device. Since communities are supposed to make financial contributions to buy the spare parts and cover transport costs, this proved to be expensive and to be beyond the reach of many communities. This was mainly witnessed when an expensive spare part such as a cylinder which costs an average of $USD450 would have broken down.

Spare parts for elephant pumps were unavailable from both the RDCs and local markets in Chivi District. It was reported that spare parts used to be available from Pump Aid workshop at the district offices. Pump Aid is the NGO that implemented the elephant pumps in the district. Communities indicated that spare parts had been difficult to get since the Pump Aid project ended in 2009. Communities from Chivi District have to travel to the provincial town of Masvingo which is about 65 kilometres away to buy the spare parts from private dealers. The unavailability of spare parts for bush pumps and elephant pumps indicates a weak supply chain in the rural water sector of Zimbabwe which has a negative impact on sustainability.

On the contrary, spare parts for rower pumps were found to be readily available at community level as they are manufactured locally by Dabane Trust a local NGO operating in Gwanda District. The organization has Field Officers who keep spare parts at ward level. This could explain why the lifting device had an exceptional average downtime of less than two days, between 3 and 7 days and a mean sustainability score of 75.30% which is in the highly sustainable category while other lifting devices were in the partially sustainable category (Table 4.8).

Communities considered the cost of spare parts for bush pumps to be generally higher than those of other water lifting devices. When parts such as cylinders and pipes need to be repaired, a long time is required to make financial contributions thereby depriving communities access to water. Although the spare parts for bush pumps were considered to be expensive they are more durable than those of rower pumps (Dabane Trust 2014). An example are the leather cups used on bush pumps which cost USD$5 and take an average of 6 months to be replaced. On the other hand, spare parts for rower pumps although they were considered to be affordable, they have a shorter life span (2-3 months) for parts such as cup seals and rubber washers which cost USD$3.

Pump status

Pump status was established by assessing the condition of the head works such as aprons which are not cracked, and fastened and greased parts. Head works were also checked whether they had adequate parts or not. Water points with such head works were considered to be having a good pump status. On the other hand, bad pump status was when the head works were having loose, rusty and inadequate parts. Water points with cracked aprons were also considered to be having a bad pump status. An average of 44% of the water points were considered to be in a bad status. Observation results showed that, some of the lifting devices did not have adequate parts. Parts that were missing on most bush pumps were bolts, pipes and in some cases the pump handles. As for the elephant pumps, ropes were the commonly missing parts. Nyanga District had the highest percentage (52%) of water points with missing parts while Gwanda had the least (38%). Across technologies, it was observed that elephant pumps had the highest percentage (58.8%) of water points with missing parts while rower pumps had the least percentage (19.3%) (Table 4.9).

Table 4.9 Proportion of water points without adequate parts by water lifting device.

Type of water lifting device	**% without adequate parts**
Elephant pump	58.8
Bush pump	45.9
Windlass	22.1
Rower pump	19.3

The chi square test results (χ^2 =24.8, df=4, p<0.01) show that missing parts vary significantly with water lifting devices. Water lifting devices which did not have adequate parts were reported to be having frequent breakdowns. An example is where steel pump handles were replaced with wooden pump handles and where wire was used to tie parts instead of bolts. Bad pump status was attributed to vandalism, unavailability of spare parts at local level and absence of preventive maintenance.

4.5.2 Institutional factors

The institutional factors which were used to assess sustainability are existence of water user committees, functionality of water user committees, level of external support, availability of rules and training in CBM.

Existence of water user committees

Water user committees which were present at water point level are Water Point Committees (WPCs) and Maintenance Committees (MCs). WPCs are the highest management committee at community level while MCs consist of water point users trained for basic maintenance of a water point. The compositions of these water user committees are presented in Chapter five. Only 18% of the water points had MCs (Figure 4.9.)

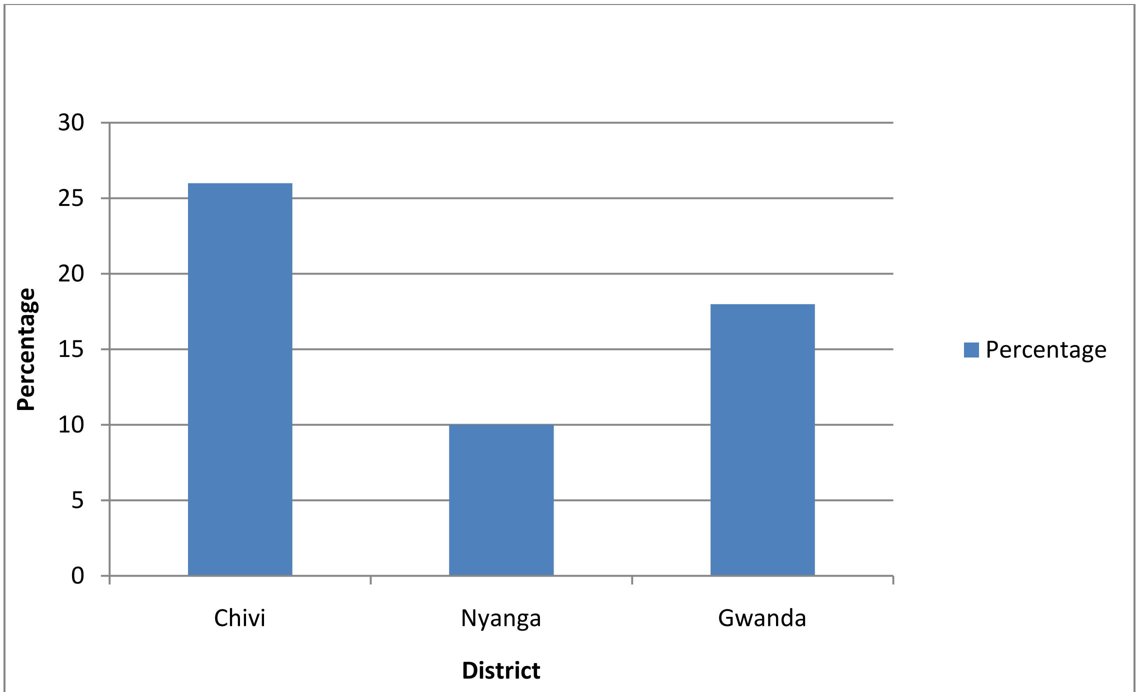

Figure 4.9: Proportion of water points with existing MCs per district

Chivi District had (26%) of its water points with MCs, while Gwanda had 18% and Nyanga had 10%. A total of 80% of the interviewed water point users with functional MCs attributed reliability of their water points to the functionality and active participation of maintenance committee members. Where MCs were absent, 58% of the respondents cited long down times (an average of 2 months). The chi square test results (χ^2 =31.02, df=2, $p<0.01$) show that the existence of maintenance committees varies significantly in all the districts. This could explain the variations in sustainability across the districts.

WPCs were found to be the most common user committees (Gwanda 98%, Chivi 97%, Nyanga 92%). However, it was noted that the existence of WPCs did not guarantee their functionality as 71% were functional in Gwanda, while Chivi had 66% and Nyanga had 64%. Results on sustainability classification show that, water points with functioning WPCs had an average sustainability score of 67.4% (Sustainable category) while those without functioning WPCs had a score of 29.8% (Partially sustainable category). Key informants (60%) cited poor coordination in collecting money for O&M in the absence of functioning WPCs. Water points without functioning WPCs were generally not well maintained and the general hygiene of the surroundings was considered to be poor as compared to those which had functional committees. Figure 4.10 shows examples of a water points with a functioning WPC and without a functioning committee.

Figure 4.10: a. Water point with a functioning WPC b. Water point without a functioning WPC

At the water point shown in Figure 4.10a, the WPC was responsible for creating a duty roaster for the general maintenance of the water point surroundings. The committee was also responsible for the fencing of the water point. On the other hand, the water point in Figure 4.10b did not have a functional WPC, and as a result the general maintenance of the water point surroundings was considered to be poor. The chi square test results (χ^2 =138.02, df=8, p<0.105) show that there is no significant difference in the functionality of WPCs across the districts. With the functionality of the WPCs averaging 67% across the districts, measures to increase the proportion of functional water points should be considered if sustainability has to be improved.

Training in Community Based Management (CBM)

The percentage of WPCs that received training in CBM was 52.3% in Chivi, 47.2% in Gwanda and 38.3% in Nyanga. Key informants indicated that, in the last ten years, no CBM trainings were financed by the government, instead all trainings during the same period were financed by NGOs. This resulted in committees of water points which were not part of NGO projects not being trained. A total of 72% of the household respondents attributed poor managerial, financial and technical performance of WPCs to absence and inadequate trainings in CBM. The chi square test results (χ^2 =4.54, df=2, p= 0.103) show that there was no significant difference in CBM trainings across the districts. All key informants at district level highlighted that low proportions of WPCs trained in CBM were attributed to the absence of a government budget on rural water supply projects. Furthermore, the limited budgets that NGOs usually have fail to cover CBM trainings for all WPCs.

Level of external Support

Communities were receiving external support in the form of training, monitoring of water point performance, repair of major breakdowns and spare parts supply. The institutions that were providing external support were the RDCs, DDF and NGOs. However, it was noted that when there are major breakdowns, communities are expected to contribute money for fuel for the DDF technical team to attend to the breakdowns. This practice resulted in some breakdowns taking long to be attended to, and it contributed to the long downtimes recorded in the study districts (Section 4.5.1). In terms of monitoring, the RDCs as the institutions responsible for the management and development of rural water supply, and the DDF as the government technical department, are expected to monitor performance of water points. Monitoring by the RDCs and DDF personnel was irregular as compared to that by NGOs. However, NGOs were only monitoring water points they would have drilled or rehabilitated under their projects. This automatically excluded water points which were not part of the projects. This finding shows that although all districts had NGOs operating in them, not all water points benefited from their existence. The operations of the NGOs are governed by the project approach which has specific targets, budgets and time frames hence their focus on certain water points.

Gwanda District had the highest percentage (60.8%) of water points that had received external support from institutions at district level while Chivi District had 54% and Nyanga District had the least (47.9%). This possibly explains high sustainability scores of water points in Gwanda District as compared to the other districts. The chi square test results (χ^2 =6.47, df=6, p= 0.042) show that there is a significant difference in water points that had received external support across the three districts.

Availability of rules on water use and management

Availability of rules is another sub-factor of institutional factors that was studied. It was observed that although rules on water use were not documented in almost 83% of the studied cases, they were known by all water users. These rules included no laundry to be done at a water point were laundry facilities are not available, reducing the amount of water collected by households during water scarce periods and participation in O&M by all water users. Participation in O&M was noted to be in cash and kind hence everyone was expected to participate. Water points which were enforcing these rules particularly the one on participating in O&M had an average sustainability score of 62% as compared to 43% for the water points which did not have such rules. This shows the impact that availability and enforcement of rules on water use and management has on sustainability. However, it was noted that in most cases those who break the rules were only given warnings and no punishments. This was mainly due to kinship ties within the communities. Some respondents noted that this caused high rates of defaulters when making O&M contributions, resulting in few households participating in O&M.

4.5.3 Environmental factors

The environmental factors of reliability of water supply, water quality at source and potential of contamination were used to assess sustainability.

Water quality at source

Water quality at source was assessed using user perceptions on smell, colour and taste of the water. User perception on water quality is of great importance on sustainability of water supply systems as users may neglect a water point if it is perceived to be providing water of a bad quality. Responses on water quality were categorized as bad, good and excellent. Generally, the smell and colour of water were considered to be of good quality across the three districts.

Nyanga had (65%) water points which were perceived to have an excellent colour while this was 53% in Gwanda and 50% in Chivi. The smell of water was generally good as 70% of the water points were perceived to be supplying water of excellent smell. However, respondents complained of boreholes which supplied water with a salty taste in 32% of the cases in Chivi, 27% in Gwanda and 9% in Nyanga districts. Water from the salty boreholes was also associated with high soap consumption. An example was noted in ward 16 of Chivi District where a borehole was neglected since the water it supplies was considered to be salty. In some cases it was reported that communities were no longer using the perceived salty water points for domestic purposes but for watering livestock. Further investigations showed that some salty water points were neglected only during the rainy season when communities will be having alternative water sources such as shallow wells which were considered to be supplying water of a good taste. During the dry season communities would revert to the salty water points as they will be the only available water source. This resulted in such water points not being maintained and repaired during the wet season.

Reliability of water supply

Reliability of water supply was studied by assessing adequacy of water supplied by a water point during the year and during the day. The amount of water supplied by water points was considered inadequate by 62% of the respondents. In Gwanda District, 60% of the water points could not supply water all year round while this was 53.2% in Chivi and 40.1% in Nyanga. In Gwanda and Chivi districts, water points usually start drying up as early as July while in Nyanga drying up of water points usually starts in August. Table 4.10 shows the percentage distribution of water points, and when they usually dry up.

Table 4.10: Time of the year when water points dry up

District	July	Aug	Sept	Oct	Nov	Dec	Supply water all year round	Total
Gwanda	1.7%	10.0%	15.8%	17.5%	10.0%	5.0%	40.0%	100
Chivi	1.0%	8.7%	13.7%	21.4%	4.4%	4.0%	46.8%	100
Nyanga	0%	6.4%	11.1%	19.1%	1.5%	2.0%	59.9%	100

Shallow wells installed with elephant pumps had a high percentage (93%) of water points which do not supply water all year round. Such water points were not maintained when they breakdown towards or during the dry season, impacting negatively on their sustainability. On the contrary, sand abstraction sites installed with rower pumps had 21% of water points that do not supply water all year round. This explains why most water points fitted with rower pumps in Gwanda District had high sustainability scores as they were considered to be reliable. The chi square test results (χ^2 =1.105, df=2, p= 0.01) show that there is a significant difference in water points that supply water all year round across districts. Intermittent water supply by some water points cause pressure on perennial ones. In 45% of the cases FGD results showed that during the dry season when some water points would have dried up, a water point could supply water to an average of 450 people compared to an average of 260 in the wet season. These figures are above the recommended 250 people per water point (Harvey & Reed 2004, GoZ, 2013).

It was also noted that some water points do not supply water throughout the day. This was common in all districts and across all water source types. Results from all FGDs showed that this resulted in queues at most water points in the mornings and evenings. A queue of people waiting to collect water is evidenced in Figure 4.11, a photograph which was taken at a rower pump in Gwanda District. The photograph was taken in the morning.

Figure 4.11: Communities waiting to collect water at a rower pump in Gwanda District

Long queues increased the time taken to fetch water in a round trip. Variations in queuing time were noted between the dry and wet seasons across districts as shown in Table 4.11.

Table 4.11: Average queuing time per district during the wet and dry seasons

District	**Average queuing time during the wet season**	**Average queuing time during the dry season**
Chivi	Half an hour	1 hour
Gwanda	Half an hour	1 hour 30 minutes
Nyanga	Less than 15 minutes	Half an hour

According to 40% of the key informants the long queues put pressure on the water points resulting in increased wear and tear of the spare parts. This contributed to frequent breakdowns of water points from once in three months during the wet season, to once per month during the dry season.

Potential of contamination

Sand abstraction sites had high chances of being contaminated by the surrounding environment during the rainy season than during the dry season. Results from routine water quality monitoring exercises which are carried out by Dabane Trust showed high levels 50/100ml of *coli form* count during rainy season and low 0/100ml *coli form* count during the dry season. Boreholes, deep wells and shallow wells with cracked aprons and without aprons showed high chances of contamination. Some of these water points (10%) were sited close (less than 30 meters) to cattle kraals while others (18%) were not fenced and animal waste was found around the water points. Notably, the chance of contamination was considered not to be of importance in influencing sustainability across the districts by 35% of the respondents. Resultantly most water points (70%) which had high chances of contamination were in the highly sustainable and sustainable categories.

4.5.4 Social factors

Community participation in planning and O&M, proportion of men and women in WPCs and conflict management are the social factors which were used to assess sustainability.

Community participation in planning

Communities participated during the planning stage of their water supply projects as 79% of the respondents indicated their participation. In Chivi District, 86% participated at the planning stage while in Nyanga and Gwanda districts 78% and 76% participated, respectively. The forms of participation and the proportion of respondents who participated during the planning stage are presented in Table 4.12.

Table 4.12: The forms of participation and the percentages of households who participated during the planning stage per district

Form of participation	Chivi (%)	Gwanda (%)	Nyanga (%)
Households aware of the water project before construction	56	60	45
Households attending meetings before water project was constructed	66	78	62
Households who participated in needs assessment	0	0	0
Households involved in decision making about type of technology to be used	0	0	0
Households involved in decision making on whether communities want the project or when the project should be implemented	0	0	0
Households involved in decision making about the site of water points	7	6	9

Table 4.12 shows non-participation of communities in decision making about critical issues on a water project. This type of participation is known as "tokenistic" or "passive" participation (Manikutty 1997). In the study area, although respondents knew about the projects before they were implemented, they never participated in needs assessment. Households neither decided whether they wanted the projects or not, nor selected their preferred type of technology. It was learnt that the technologies implemented were the choice of the donors.

A total of 72% of the respondents in Chivi District indicated that if they were consulted on their preferred type of lifting device, they preferred the windlass over the elephant pumps. The reasons which were cited are that, elephant pumps were more expensive to maintain than the windlass, and the spare parts for elephant pumps were not available at community level. Furthermore, it was noted that VPMs did not have the adequate skills to repair elephant pumps while the windlass did not require skilled personnel. These results explain why elephant pumps had long downtimes hence their dominance in the partially sustainable and not sustainable categories.

Community participation in Operation and Maintenance (O&M)

All the interviewed households indicated that they participate in O&M of their water points. Most households (87%) make financial contributions towards O&M. Interview results from 90% of the key informants show that households' financial contributions contributed to the sustainability of water points since all financial costs are covered by user communities under CBM. Water points which had more than 70% households making financial contributions were sustainable as compared to those who had the majority of the water users contributing in kind. Financial resources are needed in O&M to buy spare parts and pay the VPMs. Communities also contribute in kind in the form of grain, small livestock, labour and/or locally available material during O&M. In kind contributions complement the financial ones as they reduce the total costs of maintaining a water point. However, this variable does not tell if the contributions are adequate to cover the O&M costs, and this will be discussed in Section 4.5.5.

Communities also participate during the O&M stage by monitoring water points' performance. In 68% of the cases, monitoring is mainly done by women when they visit water points to collect water. Monitoring results were reported to the WPCs, Village Health Workers (VHWs) or village heads. The importance of monitoring is to observe any changes that could be taking place on the water supply system. This allows appropriate preventive measures to be taken to avoid major breakdowns.

Repairing water points is another form of community participation that user communities do at the O&M stage. Participation at this project stage reduced the downtime period from six months which was the average downtime when water points were maintained under the central system (NAC 2005) to an average of two months. The reduction in the downtime has been attributed to the immediate responses to break downs.

Conflict management

Conflicts were recorded at most water points (71%) in the study area. These conflicts were common during the dry season when water supply will be inadequate. It was reported that some households would collect high water quantities especially at night, thereby disadvantaging others. Conflicts were also experienced when households from neighbouring villages collect water from water points disadvantaging the regular water point beneficiaries. Although there are no clear cut catchment boundaries for water points, the regular water point users where the households who make contributions towards O&M of a water point. In Nyanga District two water points were vandalized when conflicts between water users were not properly resolved. This result shows the need for conflicts to be properly resolved to enhance sustainability.

Some water points (27%) reported conflicts that resulted from the mismanagement of the tool boxes. Conflicts on the misuse of the tool boxes were reported in all the districts. The tool boxes were shared by a minimum of three wards and in all cases it was not clear who was supposed to keep the tool boxes. This impacted on sustainability negatively by increasing the down time of water points as VPMs reported spending an average of more than a week trying to locate the tool box when they want to attend to a break down. Although the magnitude of these conflicts varied, conflict management skills were noted to be of importance within communities.

WPCs are expected to solve conflicts among water users when they occur. However, 67% of the respondents rated WPCs under the "unable to solve conflicts" category. This has resulted in communities turning to traditional leaders for solutions when conflicts have arisen. Communities justified their choice of traditional leaders to solve water use conflicts as they are regarded as custodians of traditional law. The way the traditional leaders settle conflicts was also considered to be transparent by most respondents (56%). Their practice was described as bringing the parties in conflict together to discuss the cause of conflict, finding a solution and reaching a settlement. This was unlike some WPC who were reported to be causing confusion than solving conflicts between water users. Where conflicts are properly managed it was noted that they may cause co-operation between the parties in question.

Proportion of men and women in WPCs and MCs

It was noted that only 24% of the studied water points had female members in the MCs. Communities perceived the nature of work involved to be for males due to muscular power required. However, it was found out that 47% of the trained MC members across the districts had migrated to towns and neighbouring countries such as South Africa and Mozambique in search of employment. On the other hand, WPCs had a higher proportion (78%) of women than men. More women were members of the WPCs as they are considered to be more committed to household water management than men (Sara & Katz 1997). The few men who were trained to be WPC members were also found to have migrated in search of employment. Social and cultural norms appear to be the major reason why more female trained WPC members are still in the area compared to male members. Generally men may be away from their rural homesteads working in towns to raise income, while women remain in the rural areas taking care of the family in Zimbabwe. This suggests the need to involve and train more women in community structures for sustainability to be enhanced as they are less mobile than their male counterparts.

4.5.5 Financial factors

The presence of an O&M fund, regularity of making financial contributions, adequacy of the O&M funds, and availability of rules on fee collection are the financial factors which were used in sustainability assessment.

Presence of an O&M fund and regularity of making financial contributions

The O&M fund was found to be available at 29.6% of the water points. Nyanga had 18% water points with an O&M fund while Chivi had 31% and Gwanda had 40.7%. Water points that had the fund had high sustainability scores and were in the sustainable and highly sustainable categories. KIIs and FGDs results showed that the absence of the fund was mainly due to irregularity of making financial contributions and poverty. In terms of poverty, it was noted that the communities had no stable monthly income since they are agriculture-based communities, and money is often available following harvests than at any other times of the year. The socio-economic status of the households showed that across the districts, households had little monthly income (average $38) which was shared among a number of activities such as purchasing food, paying school fees, paying medical costs and buying agricultural inputs. Priority was given to the other expenditures as they were considered to be more pressing than contributions towards O&M of water points.

The frequencies of making financial contributions per district are shown in Figure 4.12.

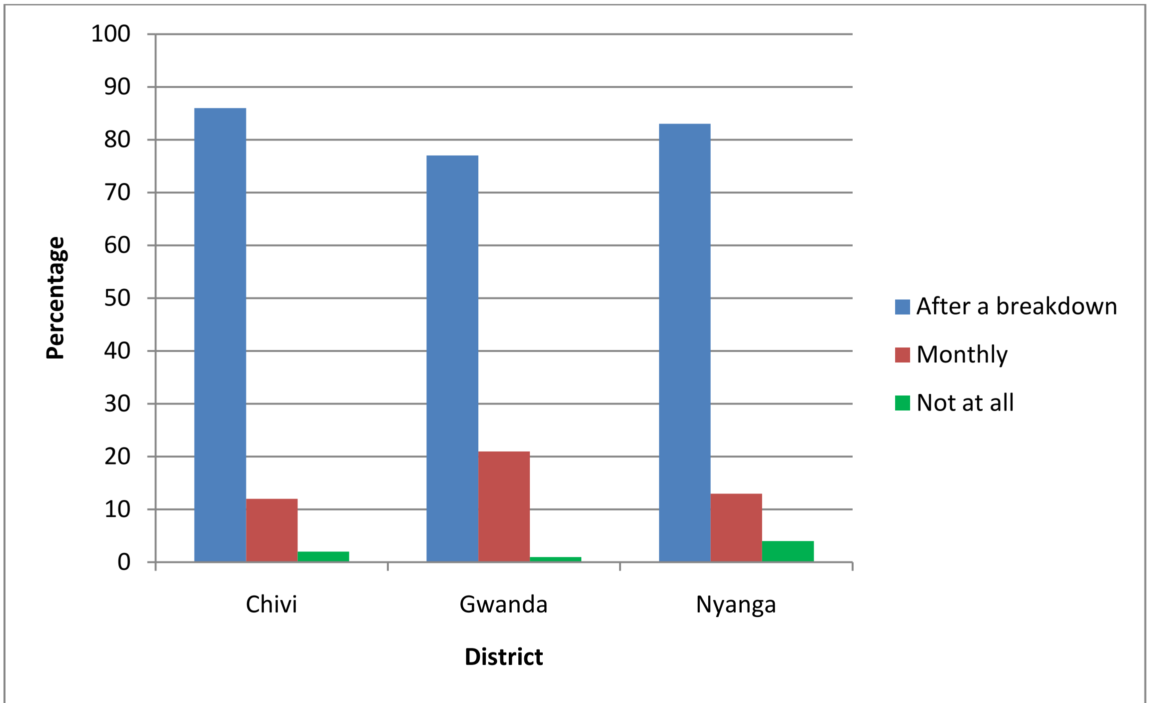

Figure 4.12 Frequencies of making financial contributions for O&M per district

Gwanda had 21% households which were making monthly financial contributions while Chivi had 12% and Nyanga had 18%. The majority of the households preferred to make financial contributions towards O&M after a break down when they will be seeing the need and urgency to pay for the repair. Making financial contributions after a breakdown increases the down time as time is needed to mobilize the community to contribute the funds. Coupled with the time required to purchase and deliver the spare parts, most water points without the O&M fund had downtimes of 2 months (Section 4.5.1). This shows the effect of irregularity of making financial contributions and poverty on the sustainability of water supply systems.

Rules on fee collection

Chivi District had 41% water points with rules on fee collection, while Gwanda had 39% and Nyanga had 38%. Water points which had such rules had most (70%) of their water users contributing towards O&M. The O&M fund of water points which had rules was almost $20 at the time of the study as compared to $3 for those which did not have rules. Absence of rules made some community members to be reluctant to make making financial contributions, which negatively affected the willingness to pay by regular contributors. It was also noted that poor enforcement of rules at some water points rendered the rules ineffective in promoting sustainability.

Adequacy of O&M funds

The funds which were being collected towards O&M of water points were not adequate in 68% of the cases. The cost of repairing and maintaining a water point was estimated to be between $30 and $150 per year (Figure 4.13).

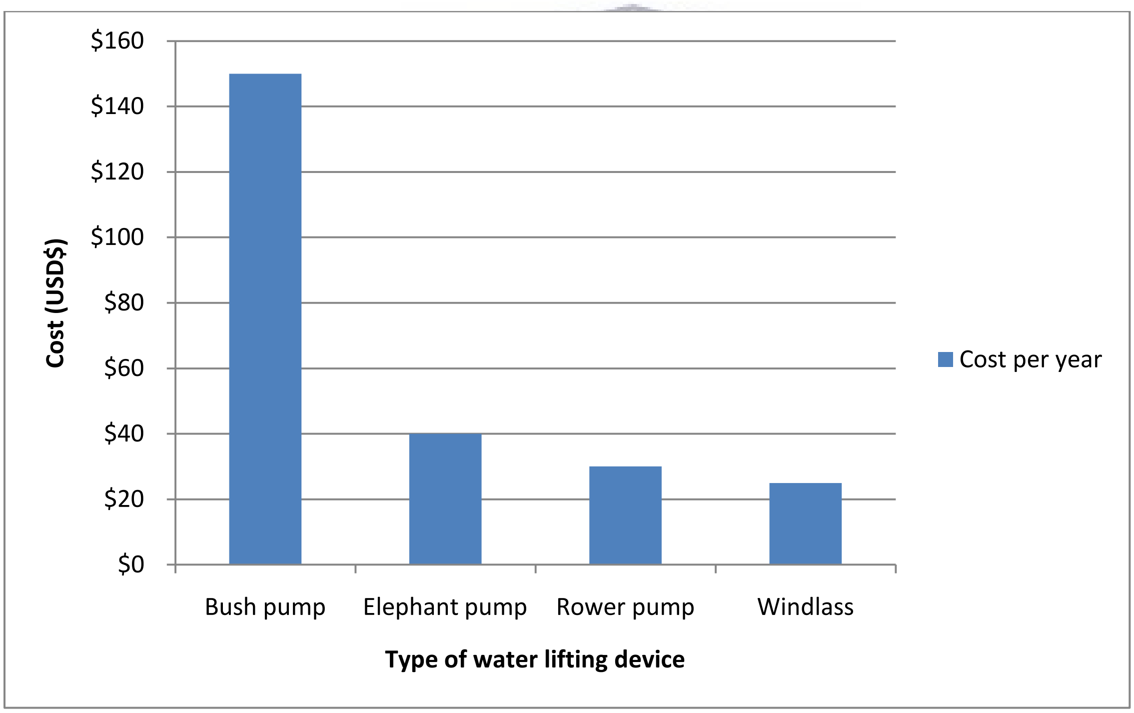

Figure 4.13: Average cost of maintaining a water point across lifting devices per year

The average cost of maintaining a water point varied depending on the type of lifting device in question, the magnitude of the breakdown and whether the spare parts were found at community, district or provincial level. The costs were high where major parts such as cylinders, pipes and pump handles for bush pumps would have broken down. The costs also included the labour costs of VPMs. The VPMs charged an average of \$70 per repair for bush pumps and \$20 for elephant pumps. Repairs of rower pumps and windlass were considered not to be difficult, hence the communities were not engaging VPMs as they were doing the repairs on their own. These costs show that although communities were making contributions towards O&M, the contributions were not adequate since most water points had funds of between \$0 and \$20 during the time of study. The inadequacy of O&M funds increases the downtime period as more time will be required to mobilize the funds.

4.5.6 Exploratory Factor Analysis results: Key influential factors of sustainability

After determining all the factors influencing sustainability, an Exploratory Factor Analysis (EFA) was conducted to determine the key factors. EFA was done using the procedure outlined in section 3.5.3. On the basis of extensive literature and the pilot study which was done, a total of 27 factors presented in Table 4.13 were considered for EFA.

Table: 4.13: Sustainability factors considered for the EFA

Factors	**Mean**	**Std. Deviation**
Community participation in planning	1.20	.40
Conflicts in management	1.59	.56
Functionality	1.40	.49
Time a water point has not been functioning	7.54	2.78
Average down time	4.00	1.78
Reliability of water supply	1.50	.50
WPCs having adequate skills	1.52	.61
VPMs having adequate skills	1.67	.57
Training in CBM	1.73	.43
Availability of spare parts	1.78	.41
Affordability of spare parts	1.70	.45
Level of external support	1.54	.49
Pump Status	1.56	1.09
Water quality at source	1.67	.48
Conflict management	1.57	.60
Community participation in operation and maintenance	1.55	.49
Functionality of committees	1.90	.33
Availability of rules	2.44	1.40
Potential of contamination	1.38	.48
Rules on fee collection	1.03	.18
Conflict management	1.46	.49
Adequacy of operation and maintenance funds	1.39	.48
Proportion of men and women in WPCs	1.59	.49
Presence of O and M fund	1.75	.43
Regularity of making financial contributions	1.61	1.14
Presence of spare parts supply chain	2.01	1. 45
Participation in planning by vulnerable groups	1.46	.49

Factor rotation

Of the 27 factors/items which were analyzed using EFA, 15 were dropped since they had a loading of less than .30. The remaining 12 items had satisfactory loading values ranging from .492 to .911. (Table 4.14).

Table 4.14: Key factors of sustainability retained after factor rotation

Item	Factor 1	2	3	4
Level of external support	.911			
Functional committees	.878			
Training in CBM	.760			
Establishment of O and M fund		.878		
Regularity of making financial contributions		.662		
Adequacy of O&M fund		.505		
Availability of spare parts			.790	
Affordability of spare parts			.648	
Presence of spare parts supply chains			.567	
Community participation in planning				.753
Participation in planning by vulnerable groups				.601
Conflict management				.541

Extraction Method: Principal Axis Factoring.
Rotation Method: Promax with Kaiser Normalization.
a. Rotation converged in 7 iterations.

Results after rotation show that *Factor 1* is loaded with three institutional items of level of external support, functional committees and training in CBM. On the other hand *Factor 2* has four financial items of establishment of O&M fund, regularity of making financial contributions, and adequacy of O&M fund. The items that are loaded on *Factor 3* are four technical items of availability of spare parts, affordability of spare parts, and presence of spare parts supply chains. *Factor 4* is loaded with three social items of community participation in planning, conflict management and participation of vulnerable groups in planning.

Using the Eigen value rule, the retained factors had values greater than 1, ranging from 1.669 for social factors to 6.867 for institutional factors (Table 4.15).

Table 4.15: Eigen values of key factors

Factors	Eigen value	% of variance	Cumulative %
Institutional	6.867	24.86	24.86
Financial	2.353	21.47	46.33
Technical	2.047	15.30	61.63
Social	1.669	9.07	70.70

Table 4.15 also shows that the four factors explain a total variance of 70.7%. The institutional factor had the highest Eigen value of 6.867 and it represents 24.86% of the variance related to the factors. The second factor which is financial had an Eigen value of 2.353 and it represents 21.47% of the variance. Technical factors were third with an Eigen value of 2.047 and 15.30% variance while the social factor was fourth with an Eigen value of 1.669 and a variance of 9.07%.

The EFA results show that institutional factors are of great importance in influencing sustainability of water supply systems. The institutional sub-factors which are critical are level of external support, functional committees and training in CBM. The financial factor is the second in importance. Under this factor, sub-factors of establishment of O&M fund, regularity of making financial contributions, and adequacy of O&M were considered to be key. Thirdly technical sub-factors of availability of spare parts, affordability of spare parts, and presence of spare parts supply chains were also found to be important in influencing sustainability. The fourth factor that was found to be of importance is the social factor with its sub-factors of community participation in planning, conflict management and participation of vulnerable groups in planning. These results show that for sustainability to be achieved these key factors have to be addressed. Their incorporation into different project stages will allow the development of a sustainability framework that will be used to promote sustainability in Zimbabwe (Chapter Seven).

4.6 Discussion

The main aim of the chapter was to investigate the factors influencing sustainability of water supply systems in rural areas of Zimbabwe. The factors found were broadly categorized into institutional, technical, social, environmental and financial. From the results, it is notable that 33% of the studied water points were not sustainable according to the author's classification discussed in Chapter Three. Some of the water points in the sustainable category had low sustainability scores which may likely drop into the partially sustainable range. The high proportion of unsustainable water points is what the literature on rural water supply would suggest to be the case for developing countries. In the sub-Saharan Africa region, unsustainable water points of between 20-40% have been reported on (Harvey & Reed 2004; Peter & Nkambule 2012). At national level these results are not unique as studies by Hoko et al. (2009) and Dube (2012) also showed high levels (38-70%) of unsustainable water points in some parts of Mt Darwin and Gwanda districts. This implies that, although governments of developing countries may continue to invest in the implementation of physical infrastructure, communities may not enjoy the intended benefits of the investments if sustainability problems are not solved. Thus, for such investments to positively contribute towards the achievement of the SDGs in the rural water supply sector, the underlying factors of sustainability should be known since the provision of improved water points is not enough if the facilities are not sustained.

On technical factors, there was evidence that the type of lifting device used significantly influence sustainability. The ANOVA results show that there is a significant difference in the mean overall scores of sustainability for different lifting devices. Notably, the sustainability scores of simple technologies such as the rower pumps and the windlass were higher than that of the bush pumps. These findings are not exceptional from findings from other sustainability studies done in Africa which show that, where the management of systems is done by communities, simple technologies are more sustainable than those which are considered to be complex (Harvey & Reed 2007; Machiwana 2010; Sarmuko & Yanja 2013; U-Dominic et al. 2015). In South Africa, simple technologies were also found to be cheap to maintain and more sustainable than sophisticated ones (Bamush & Yamar 2006). However, the elephant pump, another simple technology which was used in the study area was not sustainable with a sustainability score of 48%. The contrast of the findings on elephant pumps from what is expected in literature was partly attributed to the absence of spare parts at both community and district level for the lifting device. These results concur with Prokopy et al. (2008) who noted that, unavailability of spare parts for hand pumps had a negative influence on sustainability in

India. In this regard, establishing supply chains through registered private dealers may ease the problems of spare parts availability and the supply of sub-standard spare parts. This shows that availability of spare parts which is a technical sub-factor depends on institutional factors, in this case institutions that provide standard spare parts.

The availability of technical external support was found to be contributing to the short down time (less than a week) for rower pumps while bush pumps and elephant pumps which did not have the same support had an average downtime of 2 months. These results are similar to the findings by Whittington et al. (2009) that ongoing technical support contributed to sustainability in Bolivia, Peru and Ghana. It is important to ensure that the downtime is kept short for sustainability to be achieved. Carter (1999) argues that a pump which breaks down frequently, but which is quickly repaired is better than one that breaks down infrequently, but takes long to be repaired. However, it should be acknowledged that, although the average downtime of 2 months is above the stipulated downtime for sustainable water points (2 days), it is lower than that of the centrally managed three-tier O&M system, which was 6 months (NAC 2005). This shows an improvement brought about by CBM in rural water supply in Zimbabwe.

Results on functionality show that 41% of the water points were not functioning. These results are consistent with the theoretical expectations as literature has shown that at any given time 30-70% of rural water supply systems are not functioning in the sub-Saharan Africa region (Harvey & Reed 2004; Mwnagi & Daniel 2012; Dube 2012). Further analysis show that functionality differed significantly with type of lifting device. The lifting device (rower pump) which had a low proportion of non-functional water points had also the highest sustainable water points. This suggests that where a water point will be functioning other factors of sustainability such as institutional, social and financial will be in place as was evidenced by the survey results. The lifting device (elephant pump) which had the highest proportion (59%) of non-functional water points was also found to be performing badly in other sustainability factors hence its low (48.03%) average sustainability scores. This result clearly shows the inter-linkages that exist among sustainability factors as shown in the Sustainable Livelihoods Framework (SLF). Such relationships need to be known to enhance the overall sustainability of water supply systems.

Water lifting devices which were considered to be easy to use were found to be more sustainable than the difficult ones. Results show that rower pumps were more preferred than bush pumps as they can be used easily by children, the elderly and the physically challenged. These results are in line with findings by Hoko et al. (2009) who recorded 70% bush pumps which were considered to be difficulty to use in Mt Darwin District of Zimbabwe. In another study, Hoko & Hertle (2006) linked frequent of breakdowns in Mangwe District of Zimbabwe to high number of strokes which increases wear and tear of bush pumps. Smith (2011) also noted that communities were willing to maintain water lifting devices which were simple to use than the difficult ones in South America. This shows that, lifting devices which are difficult to use may suffer physical breakdowns or may be neglected by users resulting in low sustainability. This possibly explains why rower pumps were dominating in the highly sustainable and sustainable categories than the bush pumps.

Water points that were functional and were in the highly sustainable and sustainable categories had functional WPCs and MCs, while most of the unsustainable water points did not have functional committees. This implies that, sustainability is threatened by the non-functionality of user committees. These results resonate with findings by Marks et al. (2014) when they concluded that, communities which had user committees had more sustainable water supply systems than those who did not have such committees in Ghana. Other scholars who emphasized on the importance of functional user committees in promoting sustainability are Harvey (2008) and Whittington et al. (2009). However, results showed that such committees need to be capacitated in conflict management, managerial, technical and financial skills through CBM training for sustainability to be enhanced. The low percentages of trained WPC in CBM in the study area had a negative impact on other factors of sustainability such as technical, financial and social factors. Such inter-linkages show the need of addressing sustainability in a holistic manner since an investment or a weakness in one factor may influence the other factors.

Communities were not given a chance to make decisions on the type of project and or technology they want during the planning stage. These results explain why elephant pumps had long downtimes hence their dominance in the partially sustainable and not sustainable categories. This is consistent with the majority of published empirical studies on participation, where nonutilization of local knowledge at the needs assessment stage led to low sustainability of water systems considering different community preferences (Manikutty 1997; Prokopy 2005). U-Dominic et al. (2015) concluded that non-participation of communities in technology selection resulted in inappropriate technologies being installed in Anambra State in Nigeria. This supports the general conception that community participation in decision making leads to projects that are better designed to meet the unique needs of each community (Prokopy 2005). User communities should be given a chance to select technologies they are able and willing to operate and maintain to promote sustainability. However, this can only be achieved through active community participation during the planning stage.

The existence of an O&M fund and the adequacy of financial contributions are critical for sustainability of water supply systems. This is in line with results from other studies (Baumann & Danert 2008; Giné & Pérez-Foguet 2008; Fallis 2013). However, it was noted that irregularity of contributions was negatively impacting on the adequacy of funds which resulted in long downtimes of water points. Prokopy (2005) also found similar results where sustainability of water points was negatively influenced by inadequacy of O&M funds in India. In the same regard, Haysom (2006) also found out that water points which were contributing inadequate funds for O&M were not sustainable in Tanzania. The prevailing harsh economic conditions in Zimbabwe seemed not to spare the rural water supply sector. The communities which are supposed to fund the O&M of water systems had an average monthly income of $38 which is well below the Poverty Datum Line of $481 (ZimStat 2016). This has resulted in communities making infrequent and inadequate contributions towards O&M. These results are similar to conclusions by Dube (2012) who found out that communities in Gwanda District of Zimbabwe where failing to make financial contributions due to high poverty levels. In such cases were communities survive in deep poverty, other financing mechanisms need to be considered. The government may need to subsidize spare parts so that they are affordable for sustainability to be achieved.

Results on environmental factors show that water points which were perceived to be supplying water with a salty taste were neglected in Chivi District. These results agree with Hoko et al. (2009) when they concluded that salty water points in the Mt Darwin District of Zimbabwe were neglected and not repaired as communities used river beds and shallow wells as alternative water sources. Notably chance of contamination was considered not to be of importance in influencing sustainability across the districts. This shows that, perceived physical water quality had a more negative impact on sustainability than the biological quality despite the public health threats which are associated with water of poor biological quality. In such cases health education and provision of equipment for water treatment at household level becomes an imperative component for rural water supply projects.

The EFA results show that institutional, technical, financial and social factors are of great importance in influencing sustainability of water supply systems. The determination of fundamental factors allow the prioritization of factors where resources to invest in them are limited. The inter-linkages between the fundamental factors show that the factors depend on and complement each other for sustainability to be achieved. These relationships converge very well with the relationships of livelihood assets depicted by the SLF. However, in the SLF an asset may be substituted by other assets for example social assets substituting economic assets. This shows a divergence of the theory from sustainability factors of water supply systems as they cannot substitute one another. The presentation of the factors by Carter (1999) as a sustainability chain shows that the factors may not be substituted as the fall of one factor may disrupt the whole chain. Knowledge on fundamental factors of sustainability is critical for the rural water sector in Zimbabwe since the sector is under resourced. Such knowledge will be used to investigate how the key factors of sustainability may be incorporated at different stages of the project cycle for sustainability to be achieved (Chapter seven).

4.7 Summary

The chapter sought to answer three questions which are; what is the sustainability status of water points in the studied districts? Which factors influence sustainability of water supply systems in rural areas of Zimbabwe? Which are the key influential factors of sustainability in Zimbabwe? It was found out that water points in the studied districts could be classified into four categories which are highly sustainable, sustainable, partially sustainable and not sustainable. A high percentage of partially sustainable and not sustainable water points was a clear indication that sustainability is a challenge in Zimbabwe hence the need to understand the factors which influence sustainability.

It was shown that factors which influence sustainability are mainly technical, social, environmental, institutional and financial. Different water points were performing differently in these factors which show that rural communities have different capacities for different factors, which resultantly differentiates their sustainability status. The key factors which influence sustainability were found to be interlinked hence the need to consider all of them when assessing sustainability. Since the chapter presented the factors which influence sustainability, it was important to understand how sustainability is being shaped by the implementation of CBM. CBM is the approach that is used to implement and manage water supply systems in the rural water sector of Zimbabwe. It is in this context that the next chapter will investigate how the implementation of CBM is influencing sustainability.

5 IMPLEMENTATION OF COMMUNITY BASED MANAGEMENT (CBM) IN ZIMBABWE AND ITS INFLUENCE ON SUSTAINABILITY

5.1 Introduction

The shift of community participation to local governance in the rural water sector resulted in the adoption of the Community Based Management (CBM) approach (Khanal 2003). Although the approach has gained widespread acceptance in Southern Africa, it has not always been successful in ensuring the sustainability of water supply facilities (Lockwood 2004; Quin et al. 2011). Harvey & Reed (2007) blame the failures of CBM to the blanket application of the approach within different communities. A closer look at the principles of the approach questions its suitability to be applied as a one-size-fits-all approach as has been the practice in the rural water sector (Quin et al. 2011). The basic principles behind the approach are that, the community that benefits from an improved water supply should have a major role in its development, own the water system or facility, and have overall responsibility for its O&M (Moriarty et al. 2013). The application of these principles needs careful consideration as communities in different localities may have different capabilities in managing the water supply systems.

The fact that the approach has managed to produce favourable results in some areas (Narayan 1993; Opare 2011), shows that the approach can work. What may need to be understood is how the approach is being implemented / applied in different contexts. The way the approach is applied may have an influence on sustainability of water supply systems (Lockwood & Gouais 2011). Quin et al. (2011) argued that "no one is willing to walk the talk" when implementing CBM in the water sector, meaning that although frameworks or guidelines are formulated they are not being implemented accordingly. In reference to this statement, CBM could be failing to produce expected results because its guidelines are not followed while claims of using the approach are made.

In Zimbabwe a CBM implementation guide was developed to assist in the implementation of the approach. The CBM guidelines should be followed by all stakeholders and organizations in the rural water sector. It is against this background that this chapter aims to investigate how CBM is being implemented in Zimbabwe, and how the discrepancies between theory and practice in its implementation are influencing sustainability of water supply systems. The specific questions which will be answered in this chapter are:

i. What are the roles of different institutions in the rural water sector as outlined in the CBM implementation guide, and what are their practices in CBM implementation?
ii. How does the implementation of CBM by different stakeholders affect sustainability of water supply systems?

An understanding of how CBM is being implemented by different stakeholder in Zimbabwe will help to overcome any identified gaps in the implementation of the approach for sustainability to be achieved.

5.2 The CBM implementation guide/ framework used in the rural water sector in Zimbabwe

The CBM implementation guide was prepared by the National Action Committee (NAC), for use by the institutions and organizations in the water and sanitation sector (NAC 2005). The NAC is an inter-ministerial committee responsible for the overall coordination and management of the water, sanitation and hygiene (WASH) sector. The purpose of the guide is to provide water and sanitation programmes with a framework on how to implement CBM. The CBM implementation guide also aims to give direction to stakeholders to empower communities to manage, make decisions, and provide the necessary resources needed to develop, operate and maintain their water and sanitation facilities. The guideline highlights roles of different institutions in CBM implementation and the skills which are required. Notably, the framework is a reflection of some of the legal and policy frameworks used in the water sector in Zimbabwe.

According to the CBM guidelines the communities are responsible for the development, and O&M of water points. The communities are also supposed to monitor the performance of water supply systems and repair non-functional ones. The CBM guidelines also stipulate that decision making on the type of technology rests with the community of users. To facilitate this, water projects implementation organisations should provide information to the community on possible choices and their long term financial implications especially on O&M. Communities should also develop village based plans which should be the basis of channelling support from the government and donors.

At the district level the CBM guidelines stipulate that the Rural District Councils (RDCs) should establish a Revolving Fund to provide loans and grants to communities intending to develop or improve their water supply systems. The revolving fund should also be used to subsidize slow moving items such as pump heads, cylinders and pipes. The RDCs are also supposed to allocate 15% of their annual budget to water supply and sanitation projects. The CBM guidelines also indicate that the RDCs should incorporate in their plans, water and sanitation projects and they should make it mandatory that villages have development plans indicating priorities, options and costs. The CBM implementation guide also indicate that the RDCs should support the establishment of community structures responsible for water management and they should also put in place legal instruments such as by-laws to support the established structures. These structures include the WADCOs, VIDCOs, water, and health committees.

The CBM guidelines also stipulate that NGOs and other implementation organizations are supposed to build the capacity of the major stakeholders to effectively play their roles. The trainings which should be done are for WPCs, Village Pump Minders (VPMs), well sinkers and headwork builders. The District Water and Sanitation Sub-Committees (DWSSCs) are responsible for the monitoring of water points performance as well as monitoring the implementation of CBM by different stakeholders.

5.3 Roles and practices of Rural District Councils (RDCs)

The CBM framework stipulates that the RDCs are accountable for water supply and sanitation at local level. They own and manage public rural water and sanitation assets, whether developed by central government, local government or NGOs. In this regard, the councils are required to include rural Water Supply and Sanitation (WSS) in their annual budgets and commit at least 15% of their budgets towards the development and management of WASH services. The budgets of the three districts which were studied showed that between 2014 and 2016, the main capital investments were land developments, schools developments, health developments, purchase of vehicles and rural electrification (Table 5.1). The table shows that Nyanga RDC was not allocating funds for the development of rural water supply systems in the three years which were studied (2014-2016).

Table 5.1: Estimated RDCs' budget allocation for capital expenditures for 2014 to 2016 (%)

District	**Nyanga**			**Chivi**			**Gwanda**		
Year	2014	2015	2016	2014	2015	2016	2014	2015	2016
Land development	25%	31%	15%	12%	20%	10%	13%	13%	20%
Waste management	6%	8%	13%	10%	6%	8%	11%	9%	6%
Bore drilling and equipment	**0%**	**0%**	**0%**	**0%**	**0%**	**3%**	**0%**	**0%**	**5%**
Schools developments	14%	7%	10%	24%	16%	13%	8%	13%	11%
Health developments	10%	15%	16%	13%	10%	17%	20%	16%	15%
Vehicles	20%	13%	19%	15%	17%	21%	12%	18%	20%
Electrification	13%	10%	5%	10%	12%	9%	16%	12%	11%
Others	17%	14%	22%	16%	19%	19%	20%	19%	12%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%

On the other hand, Chivi and Gwanda districts started allocating funds for water supply development in 2016. The money that was allocated by Chivi District was 3% of its annual budget and Gwanda allocated 5%. Considering the cost of developing boreholes fitted with a bush pump, which are the standard water supply systems in rural Zimbabwe, the budget allocation for Chivi District was enough to develop three systems while that of Gwanda District was enough to develop four systems. The cost of developing a borehole fitted with a hand pump is between $4 500 and $7 000.

The CBM framework also highlight that the RDCs as custodians of rural water are supposed to assist communities in managing water supply systems by offering maintenance and repair services. According to the RDCs' budgets which were studied, the councils were mainly budgeting for the maintenance and repairs of equipment (which exclude water supply systems), vehicles, clinics and schools, community projects, and refuse collection (Table 5.2).

Table 5.2: Estimated RDCs budget allocations for maintenance and repairs for the period 2014 to 2016 (%)

District	**Nyanga**			**Chivi**			**Gwanda**		
Year	2014	2015	2016	2014	2015	2016	2014	2015	2016
Council buildings	7%	9%	5%	12%	14%	10%	8%	9%	10%
Refuse collection	12%	11%	14%	10%	8%	8%	10%	9%	8%
Sewer reticulation	10%	12%	8%	6%	10%	14%	15%	15%	13%
Clinics and schools	14%	10%	10%	14%	11%	13%	10%	11%	14%
Equipment	21%	21%	20%	17%	25%	17%	20%	20%	19%
Vehicles	20%	20%	23%	20%	18%	20%	21%	21%	19%
Boreholes	**0%**	**0%**	**5%**	**0%**	**4%**	**4%**	**0%**	**0%**	**5%**
Community projects	16%	17%	15%	21%	10%	14%	16%	15%	12%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%

Chivi District allocated 4% of its annual budget for maintenance and repairs of boreholes in 2015 and 2016, while Gwanda and Nyanga districts allocated 5% each in 2016. Based on the annual average costs of maintaining a borehole fitted with a bush pump, which were estimated to be between \$150 and \$200, the funds which were allocated by these districts per year were adequate to repair 2 water points per ward. Considering that most wards (61%) in the three districts have an average of 20 boreholes fitted with bush pumps, the budget allocations for maintaining the water points are inadequate. However, key informants from all the RDCs highlighted that by early September 2016, no funds had been released towards water developments and repairs. Results from 80% of the respondents showed that this was due to the dependence of RDCs on NGOs to fund water supply developments and repairs.

All the RDCs indicated financial constraints for their failure to release funds for WASH activities in their districts. The main sources of income for RDCs and their estimated percentage contribution are shown in Figure 5.1.

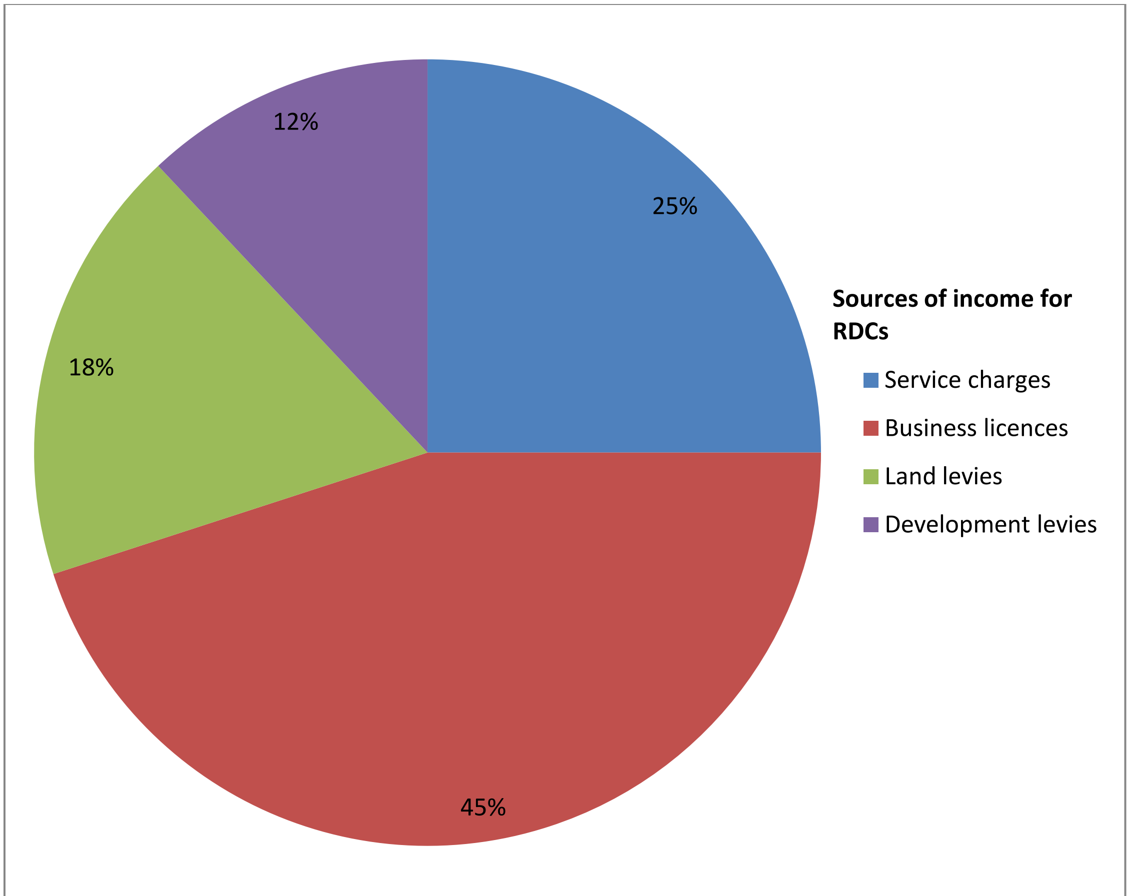

Figure 5.1 Sources of income for RDCs and their estimated percentage contribution

Figure 5.1 shows that the RDCs' main sources of income are service charges, business licences, land levies, and development levies. RDCs are supposed to have access to the Rural Capital Development Fund (RDCF) which was established under the Ministry of Transport Communication and Information Development's Department of Infrastructure Development. However, according to the respondents from the NAC, the fund has not been receiving funds from Treasury since 2011. According to 90% of the RDC respondents, money generated from land levies and development levies is negligible across the districts due to the prevailing economic conditions. Resultantly this has adversely affected the financial performance of RDCs.

The CBM framework also stipulates that the RDCs should establish a revolving fund to provide loans and grants to deserving communities intending to improve their water supply systems. The fund is also supposed to subsidize slow moving components such as pump heads, cylinders and rising mains as well as cushioning vulnerable groups in times of crisis such as drought and floods. In all the districts there were no revolving funds set. A total of 76% of the interviewed key informants highlighted that the setting up of revolving funds by RDCs is indispensable since rural communities in Zimbabwe are characterized by high poverty levels reducing their capacity in financing water supply services. Examples of where communities failed to make financial contributions are narrated below;

> "In 2009 there was a ward which had serious water shortages and the ward was selected to benefit from a water project which was being implemented by Caritas (a local NGO). However, the households in the ward failed to meet the conditions of the donor which was 25% capital contribution. This resulted in the borehole which was supposed to be drilled in the ward being allocated to a less deserving ward." **Key Informant: Nyanga District.**

> "This borehole broke down in 2007 and it used to serve 77 households from two neighboring villages. Although the breakdown was not major, efforts to make contributions for its repair were unfruitful due to the economic conditions which were prevailing during the time. After one year of not being used, the hand pump was stolen. We tried to approach different stakeholders for assistance but it was all in vain. Currently the main sources of water for the households who used to benefit from the borehole are unprotected deep and shallow wells." **Key informant: Chivi District.**

Common to these quotations is the incapacity of user communities to finance major water supply activities. This is also evidenced by the amount of funds that communities are contributing which were presented in Chapter Four. The quotations cited above show the need for revolving funds within the RDCs.

Another role of the RDCs under CBM is to develop by-laws that support the setting up of local structures under the approach. The by-laws show that local structures need to be set up at community level for the management of water supply systems. Although all districts had by-laws they were being poorly enforced since all the RDCs were not monitoring whether different

NGOs in their districts were setting up the required structures according to the by-laws. This was worsened by the fact that, 94% of the local leaders and the general community members who could be watch dogs when stakeholders do not comply with the by-laws were not aware of the existence of such by-laws. Furthermore, 62% of the council officials interviewed showed little knowledge about the by-laws as their responses were inconsistent with what was documented in the by-laws on the required management structures and their roles. Where NGOs were not complying with the by-laws no one was reporting to the council and most organizations were getting away with it. In some cases, it was noted that the NGOs would have set up WPCs but those structures would not have been trained or would be having inadequate members. This was seen to be negatively impacting on the local institutional capacity. This result shows the importance of enforcing the council by-laws and the need for effective monitoring mechanisms within the RDCs for proper implementation of the CBM approach.

RDCs are also expected to organize and hold community awareness sessions. These are crucial under CBM as user communities are the key stakeholders for the approach to have sustainable results. All councils claimed to be holding public awareness campaigns at least once every year. The awareness campaigns aim to educate user communities and improve their understanding of the CBM approach. However, it was acknowledged that councils were failing to cover all wards in their district every year. Therefore, in such cases other platforms such as community meetings were used to educate communities about the approach.

5.4 Roles and practices of Non-Governmental Organizations (NGOs)

Currently, no discussion on rural water supply is complete without considering the role of NGOs in Zimbabwe. Examples of NGOs implementing water projects in the study area include CARE International in Zimbabwe, Action Contre La Faim, World Vision, Dabane Trust, Mvuramanzi Trust, CARITAS, and Red Cross Society. The role of NGOs in the water sector has been identified as complementing government efforts in the delivery of water and sanitation to communities. This includes community mobilization, training of communities in technical and managerial issues, and construction or rehabilitation of facilities.

Community Mobilization

Community mobilization is done to engage communities identify their priorities, needs and solutions in a way that promotes participation and good governance. According to the CBM implementation guide, NGOs are expected to engage communities in water projects to ensure sustainability. All the NGOs which were operating in the studied districts mobilized the communities at the inception of their projects. This was evidenced by 100% of the reviewed NGO reports, and the high percentage (79%) of the households who participated in different activities during the planning stage.

According to the CBM guidelines, communities are supposed to select their preferred technologies during the planning stage. Although this may seem not to be practical considering the funding situation of donors, results of pre-feasibility studies may be used to select the most preferred technology before final proposals are submitted to the donors. On the contrary, all the studied NGOs mobilize communities when they will already be having the technology that they want to implement (Section 4.5.4). This negatively influences sustainability as communities are sometimes given technologies that they cannot afford to maintain. Interview results with 92% of the NGO personnel showed that, it is a requirement from the donors for them to specify the kind of technology or activity that they intend to implement to get funding. At the same time, they cannot mobilize communities first before they secure funding as it raises high expectations within communities which may be difficult to fulfil if they fail to get the funding. It was also noted that even when NGOs get to know that their interventions are not what the communities need during community mobilization, they are forced to implement them since they will be having contractual obligations with the donor. Under such scenarios it can be questioned whether NGOs operate for the benefit of the communities or for them to acquire more funding from donors? This shows the need to align NGOs' operating practices to government policies if CBM is to be implemented as outlined in the guiding framework. In such cases the use of pre-feasibility studies may be a solution.

In 20% of the studied wards, 42% of the household respondents reported that they were never sensitized when a project was brought into their community. However, further investigations revealed that the local leaders in those wards are the ones who were sensitized. Responding to this, 95% of the local leaders in those wards indicated that when the NGOs came into their wards, they wanted to start implementing the project immediately, therefore there was no time to sensitize the whole community. This shows how some NGOs do not follow some of the CBM steps during project implementation. A total of 69% of the NGO officers highlighted that such shortcuts at the community level are mainly due to bureaucracies at national and district levels which delay the implementation of projects. It was revealed that since the projects are supposed to be implemented within time frames which are very critical to donors, some steps on CBM implementation are not followed. However, 54% of the key informants highlighted that such a practice resulted in low community participation in 46% of the studied cases.

Construction and Rehabilitation of facilities

According to 80% of the key informants, NGOs were the sole funders for the construction and rehabilitation of water supply systems in the studied districts. Table 5.3 shows the amount of funds from NGOs which were allocated to the studied wards. The three main activities which were funded by the NGOs in the WASH sector for the period under review are construction or development of new water points, rehabilitation of water points, and training of communities on the management and rehabilitation of water points.

Table 5.3 Estimated amount of funding for water supply projects in the studied Districts from NGOs from the year 2014 to 2016 (USD)

District	Intervention	Year		
		2014	2015	2016
Chivi	New developments	$50 000	$30 000	$0
	Maintenance	$38 500	$50 000	$78 200
	Trainings	$3 000	$7 000	$10 000
Gwanda	New developments	$28 000	$27 000	$35 000
	Maintenance	$43 000	$32 500	$44 000
	Trainings	$7 000	$6 000	$8 000
Nyanga	New developments	$35 000	$35 000	$0
	Maintenance	$52 000	$34 000	$37 000
	Trainings	$5 000	$5 000	$ 4 000

Using the cost of developing a borehole fitted with a bush pump, the funds which were allocated to Chivi District were adequate to install eleven new water points over the three years. An average of thirteen new water points could have been developed in Gwanda District while the funding for Nyanga was adequate to install ten new water points. The number of new water points that could have been developed in the studied wards using funding from NGOs shows that water systems development is still a challenge since no developments were done in the study area by RDCs as discussed in the previous section. On the other hand, the funding that was allocated for rehabilitating and maintaining water points across the districts was adequate to maintain between 10-15% of the water points per year. The funding for trainings was considered to be inadequate by 80% of the key informants. This resulted in community structures not being equipped with the adequate skills which are critical for the management of water supply systems. These results show the need for more funding in the rural water sector for sustainability to be achieved.

During construction and rehabilitation of facilities, NGOs work closely with DDF, RDCs and Ministry of Health and Child Welfare (MoHCW). KII results show that, 68% of the government employees raised concerns over the time some NGOs want facilities to be rehabilitated or constructed. In their view, 37% of the facilities in the study area were implemented during a short space of time which they termed “rushed implementation”. An example was given in Chivi District where 23 of the elephant pumps were installed on shallow wells as the implementing organization indicated that their project did not have enough time to deepen the wells. This in turn, had impacts on the quality of constructed facilities as well as the level of user participation. FGDs results show that in 29% of the cases where households did not participate in the installation of water points, their participation in O&M also tended to be low and affected sustainability of water points. This result explains why community participation is said to be indispensable for sustainability to be achieved under CBM (Harvey and Reed, 2004).

On the other hand, NGOs blamed government stakeholders for not giving them the full technical and political support they needed during the construction and rehabilitation of water points. According to 72% of the NGO respondents, government employees expected to be paid for the time they spent supporting water supply and sanitation programmes funded by NGOs. Although this is not supposed to be the case since the government officers will be doing the work in their areas of jurisdiction, this was claimed in the form of travel and subsistence allowance. According to 60% of the NGO records which were reviewed by the researcher, it was estimated that an average of 11% of the total project budget was being used to pay government employees. If the NGOs are complementing government efforts as stated in the national policies, then government employees should be expected to offer their expertise for free when working in their localities. Paying government employees, only short changes the budget for project implementation which is already not adequate for water supply goals to be met. Responding to this result, 83% of the government workers considered NGO programmes to be extra work hence the need to be paid. There was a general view among government workers (60%) that NGO projects have huge budgets, thus they should be given allowances to supplement their salaries. The practice of paying government workers has negatively influenced sustainability as government stakeholders were not willing to participate in NGO projects which do not pay allowances. In such cases it was reported that students attached to governments departments who will still be under training are the ones who participate in the NGO projects.

5.5 Roles and practices of District Water and Sanitation Sub Committees (DWSSCs)

The DWSSCs co-ordinates planning and assists in the management of rural water supply activities in a district. The committee consists of all relevant sector agencies represented in the district and representatives from NGOs which may be co-opted by the committee. The sub-committee is chaired by the Rural District Council (RDC) and reports to the Provincial Water and Sanitation Subcommittee (PWSSC) and the Rural District Development Committee (RDDC). A total of 54% of the DWSSC members across the districts highlighted poor coordination within the committee. It was noted that most stakeholders (80%) in the committee mainly focus on their key result areas and do not prioritise WASH activities. Results from 79% of the key informants at district level also revealed that meetings for the committees were not well communicated and some information concerning WASH was not shared among all committee members. In Chivi and Nyanga districts, the poor coordination was blamed on political influence by 42% of the respondents.

Monitoring is one of the key roles of the DWSSCs. It was reported that the institution was monitoring water supply activities across the districts through line ministries in the committee as well as NGOs. However, monitoring was being done irregularly by all government departments while reports from 70% of the studied NGOs did regular monitoring. According to 65% of the interviewed government employees, the irregularity of monitoring was due to financial constraints within the government departments. Although monitoring results from NGOs were helpful in preparing district plans, there were no standard monitoring tools in all the districts, and each NGO had its own monitoring tools which focused on their projects' aims and targets. The absence of standard monitoring tools resulted in inconsistencies in reporting which has an impact on the quality and adequacy of data at both district and national level. This shows the need for standard monitoring tools where several stakeholders are involved in monitoring water supply activities. Lack of financial resources also impacted on the ability of government departments in the DWSSC to keep updated databases on water coverage in their districts. For example most of the databases (62%) on water point functionality which were reviewed by the researcher across the districts were last updated in 2013. According to 48% of the DWSSC members, the databases which were found in the districts on water coverage and functionality were not adequate and were unreliable.

The DWSSC is expected to hold planning meetings once every month which are chaired by the RDC. The DWSSC chairpersons in 76% of the studied district complained of poor attendance by senior government officers to DWSCC meetings. Minutes of the DWSSC meetings reviewed by the researcher also confirmed this. It was noted that senior officers usually delegate attendance to juniors with little or nothing to contribute in the planning meetings. Responding to these allegations some senior government officers indicated the absence of financial budgets during planning. It was revealed that, during DWSSC meetings many plans are developed, however the plans do not materialize due to the absence of a budget. This result shows that, the absence of financial resources in the rural water sector has multiple adverse impacts on the implementation of CBM.

5.6 Roles and practices of Water Point Committees (WPCs)

WPCs are the highest water management institutions found at community level. Members of the committee are elected by the water point users, and they offer their services on a voluntary basis. Thus, the key element of taking over responsibility in such a committee is commitment. Positions in a WPC are those of a chairperson, secretary, treasurer, two caretakers and two committee members. Across the districts, most positions in the committees were occupied by women as shown in Figure 5.2.

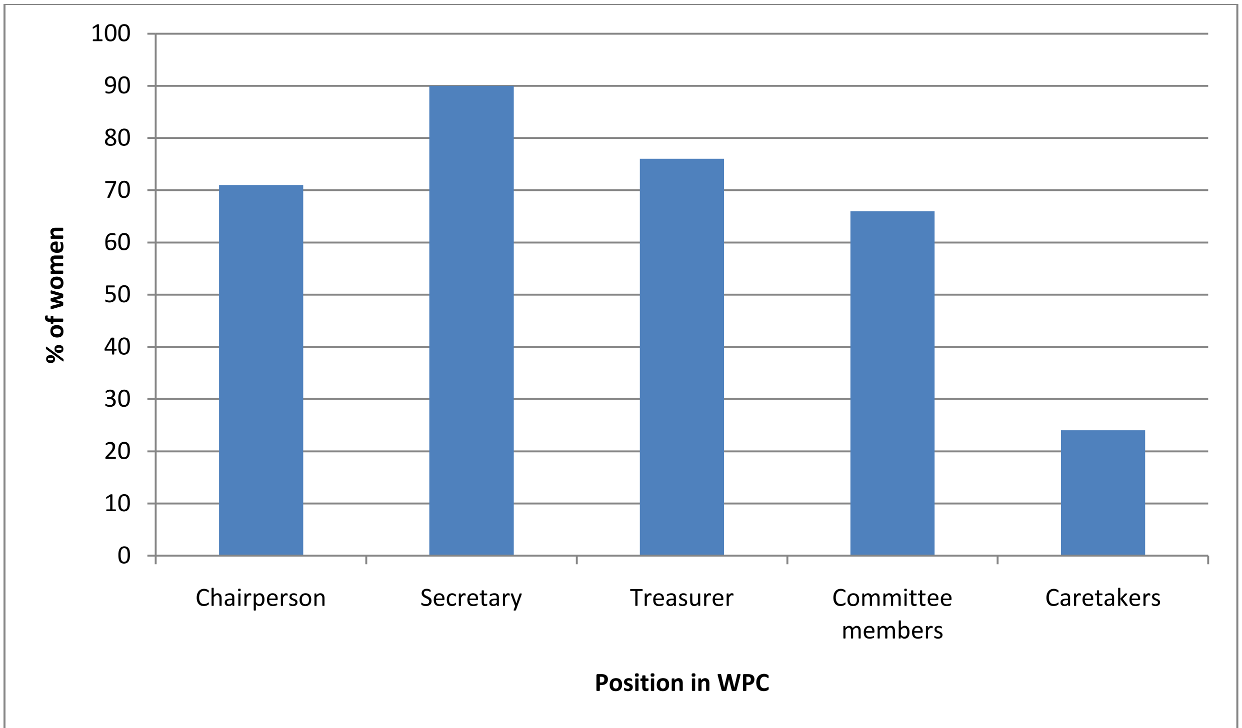

Figure 5.2 Position of women in WPCs

Most (90%) NGOs were encouraging the election of women into influential positions such as chairperson, treasurer and secretary. Notably, there was low (24%) membership of women in WPCs as caretakers as it was considered to be a technical job that requires muscular power. Where women were caretakers, their technical capacity was reported to be low. Adequate technical capacity building is therefore required, before women take up positions which require such skills for sustainability to be achieved.

The WPCs are supposed to carry out a number of tasks which include, setting up an O&M fund, collecting O&M funds from water users, organizing meetings, carrying out preventive maintenance, and attending to minor repairs. The following sections discuss how these tasks are being performed by WPCs.

Setting up and collecting Operation and Maintenance (O&M) funds

According to the CBM implementation guide, the responsibility for O&M and replacement of water supply systems lies with the users. This requires WPCs to establish an O&M fund at water point level where regular contributions should be made. Results on the existence of O&M funds in the study area are presented in Section 4.5.5 where the fund was found at 29.6% of the studied water points. The absence of the fund at most water points was due to irregularity in making financial contributions, poverty, unpredictable economic situation in the country and mismanagement of funds. The impact of poverty and irregularity of making financial contributions were discussed in Chapter Four and the impact of the unpredictable economic situation and mismanagement of funds will be discussed in this section.

Most households (58%) reported that they stopped making regular contributions in 2006 when the inflation rate was high in Zimbabwe. Although they acknowledged that the current use of multiple currencies has contributed to the stability of prices of spare parts, 40% of the respondents showed mixed feelings towards establishing O&M funds for water point maintenance. Across the districts, 70% of the key informants indicated that experiences of the communities during the hyperinflation period in Zimbabwe reduced their confidence in regularly contributing towards O&M. Ironically, the same respondents revealed that they were making contributions and savings in other forums such as burial societies and Internal Savings and Lending (ISAL) groups in which they were members. Although these forums also stopped functioning during the hyperinflationary period, they were resuscitated and promoted as a result of dollarization in Zimbabwe. One would then question why regular contributions on O&M for water supply services are failing to benefit from the dollarized economy, within the same communities where other activities of the same nature are benefiting. This indicates how challenging it is to implement CBM in economically unstable countries. Where financial contributions will be required, communities need to be sure that their contributions will not be affected by temporal economic changes.

Respondents of household questionnaires (61%) echoed their lack of trust in WPCs to keep their money. Reports on the misuse of water user funds by WPCs were made across the three districts. This is revealed in the following quotations;

> "My household has stopped contributing money for O&M on monthly basis because there is no one who can keep it. The treasurer in the WPC uses the money for her own business. She does not record the expenditures so that she is not caught. Efforts to make her record the expenditures did not yield any fruitful results." **Household head 1; Nyanga District.**

> "Firstly it was the treasurer who disappeared with our money. She used the money for her bus fare to follow her husband who is now staying in South Africa. Now the money is kept by the chairman of the committee and the situation is even worse as he has reported in two occasions that he misplaced the money. Coincidentally during the same period he was seen drinking clear beer at the shopping centre. The whole community is convinced that he used the money to buy the beer….. ." **Household head 2; Gwanda District.**

Although the WPCs reported that they were failing to set up and collect funds for O&M regularly due to the economic situation in Zimbabwe, this was not the only reason given. Instead, information from 43% of the interviewed household heads showed that the practices of some individual members in the WPCs made water users not to contribute the funds. In 25% of the cases, communities have resorted to have their money collected and kept by village heads. Such a practice shows how people trust their traditional leaders more than those in development structures. Recognizing the existence of traditional structures and utilizing them as alternatives when development structures would have failed may result in effective CBM implementation. However, it was noted that despite the potential that this coping mechanism has in improving regularity of making O&M contributions, it may not be a long term solution. This is because 45% of the key informants highlighted that NGOs usually use development structures even where they would have failed, without diagnosing why such structures would have failed to deliver the expected results in the first place. Harvey & Reed (2004) queried this behavior of NGOs which they termed "doing business as usual".

Study findings show that in 40% of the cases WPCs were not recording expenditures. Different reasons were given by treasurers of WPCs for not recording expenditures and the most recurring was that the money that they collect from an individual household was too little ($0.50 - $1) and in their opinion it did not warrant recording. Again, claims of knowing all regular contributors resulted in some treasurers seeing no need to record the names. It was noticed that the treasurers did not take this as an accountability issue. However, 52% of the respondents highlighted that the absence of financial records at their water points was a plan by the WPCs to misuse the money for O&M. This shows the need to train WPCs on financial management so as to avoid accusations of misusing money and to motivate water users to make contributions for the sustainability of the water supply systems. This had an impact on sustainability since water 47% of the water points which did not have financial records were not sustainable.

The financial records of WPCs were not audited by community leaders or any other community members in the few cases the financial records existed. Community based auditing, where community members or leaders audit the financial records of their water points help to instill trust between WPCs and the water point users. WPCs may help communities understand the water point's financial position by reporting back to communities the financial expenditures.

The vicious cycle of poverty, irregularity of making financial contributions, unrecorded expenditures, and unaudited financial records contributed to inadequate funds being collected by WPCs. Figure 5.3 shows the percentage distribution of WPCs and the amount of O&M funds that they collect per year towards O&M.

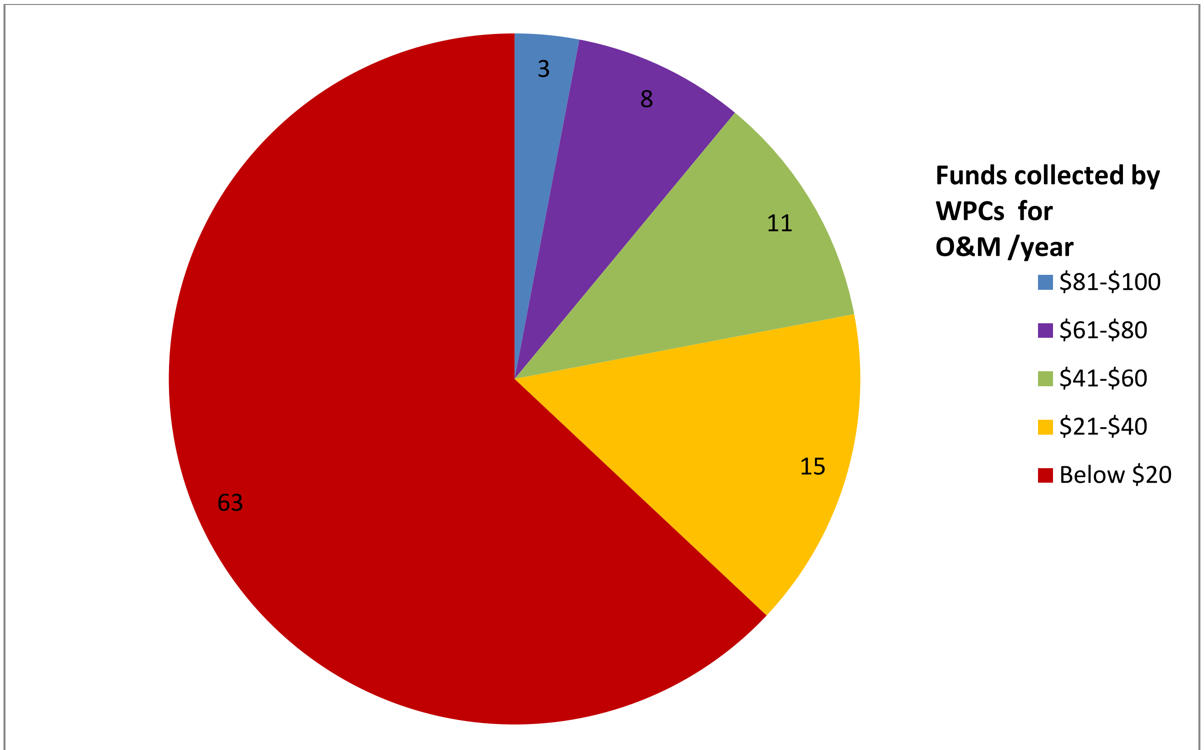

Figure 5.3 Percentage distributions of WPCs and the amount of O&M that they collect per year.

Figure 5.3 shows that the majority (63%) of the studied WPCs collect less than $20 per year towards O&M of their water points, while 15% collect between $21 and $40. The amounts presented in Figure 5.3 are below the estimated annual average costs of maintaining a water point which ranges between $25 for the windlass and $150-$200 for the bush pump (See Figure 4.13). The amounts collected by the WPCs also show that the communities are unable to develop new water supply systems as stipulated by the CBM guide. For example, to develop a borehole installed with a bush pump costs between $4 500 and $7 000, on the other hand the low cost technology which is the windlass, costs between $100 and $150. These costs show the need for external support in the form of both capital costs and O&M costs if communities are to benefit from water supply programmes.

Organizing meetings

Organizing water management meetings is another critical role that WPCs play. Across the three districts it was noted that WPCs do not regularly organize meetings. Although most (57%) of the WPCs reported to be holding meetings regularly household respondents provided different information. When asked when their WPCs had last called for a meeting, 29% of the respondents could not remember while some of them gave responses which did not show regular meetings were held (Figure 5.4).

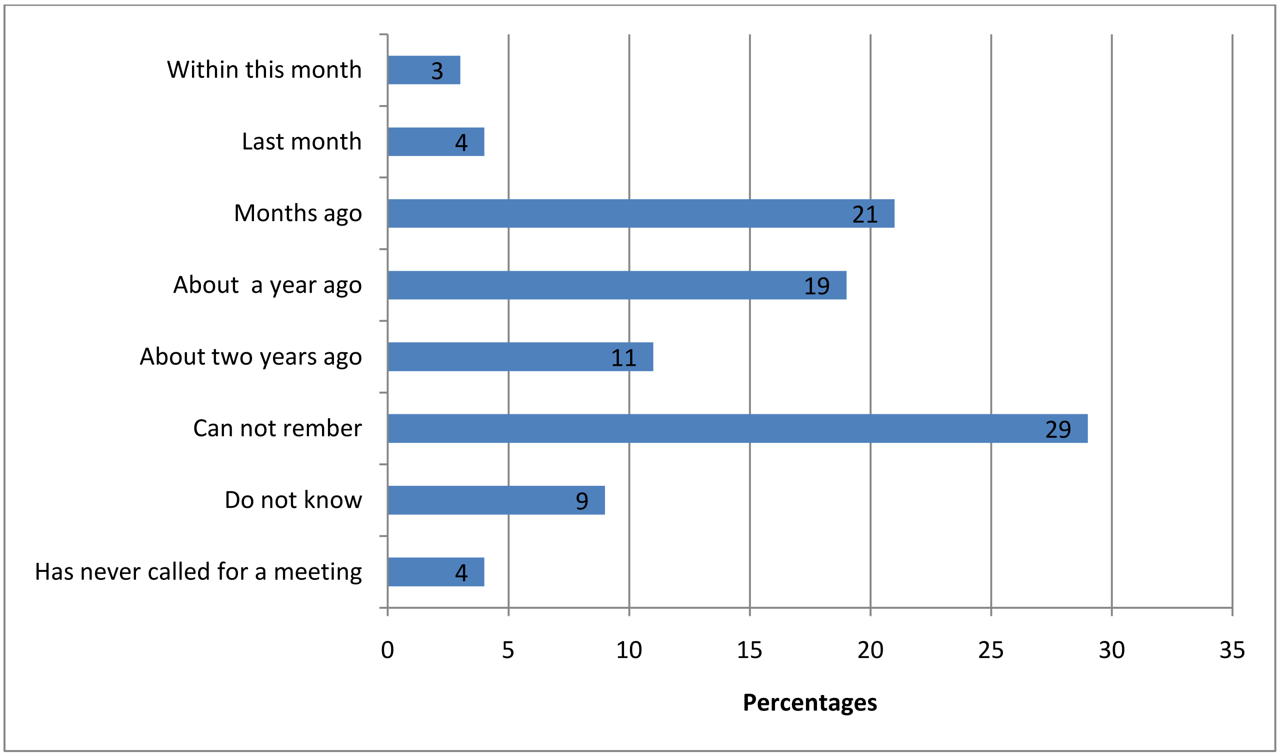

Figure 5.4: The last time WPCs had organized meetings with water users

Most respondents (71%) reported that WPCs only organize meetings when there is a break down. Some committees (51%) reported that it is pointless to call for meetings when the water point is working. According to them meetings are called when there is a problem, which usually is a breakdown. WPCs were not taking opportunities of meetings to remind and educate water users on maintenance issues. It is also within such meetings that passive committee members or those who will be deceased or would have migrated would be replaced. Meetings are also an appropriate platform to account for previous contributions so that trust between user communities and WPCs can be strengthened.

Poor attendance at meetings by water users were also contributing to irregularity of meetings. This was found in 31% of the studied cases. Most (62%) men who were not attending water point meetings indicated that meetings which did not bring income were better attended by women. They excused themselves from water point meetings claiming that they would be busy fending for their families. Minutes of meetings which were reviewed by the researcher also confirmed a general poor attendance in meetings, however this was noted to be worse for men where an average of 10% male participants were recorded at most meetings. The role of women as water managers and collectors at household level legitimizes their high prevalence at water meetings. Most women (82%) expressed fear of potential water supply problems that they may face when their water point was not taken care of hence their participation in meetings. The following quotations show the interface of women and water for domestic use at household level which make them attend these meetings.

> "When there is no water in the home, everyone experts a woman to provide it for them. Household members sometimes do not care where you get the water from, how long you travel to collect the water, how much time you take, all they need is water in their cups when they are thirsty. So as a mother you need to do everything you can to have water in your home and that you do not spend most of your time fetching water since it is not the only duty that you are expected to do" **Woman respondent aged 35; Gwanda District.**

> "You cannot talk of water in this household without talking about my wife and my two daughters. They are the ones who know where to collect and allocate the water for different uses. If the water is scarce they are the ones who know how to save it, so when it comes to water in this household l am just a child." **Man aged 51; Chivi District.**

The common threads in these quotations are that, water at household level is mainly collected and managed by women and the girl child. This explains why more women participate in water management meetings at community level than men.

Developing constitutions

WPCs are expected to develop constitutions according to the CBM implementation guide. According to the guide constitutions establish basic rules for management of water supply facilities. A low percentage (8%) of the water points had constitutions across the three districts. In Nyanga district all WPCs did not have constitutions while Chivi had 11% and Gwanda had 14%. Where the constitutions were found they did not contain all issues outlined in the CBM guide. The constitutional issues in the framework are on setting up an O&M fund, making regular contributions to the fund, election of WPC members, roles and responsibilities of different stakeholders and the communication procedures. Among these issues most respondents (59%) cited rules on O&M funds to be the most critical while 20% chose election of WPC members. A total of 40% of the key informants across the districts highlighted that the absence of constitutions was affecting sustainability since users were reluctant to perform some of their important duties such as making financial contributions. Constitutions provide a legal obligation to different stakeholders in water management therefore, their presence at water point level may help to improve sustainability.

Attending to minor repairs and performing preventive maintenance

WPCs are supposed to attend to minor repairs (tightening loose parts, replacing cup seals, etc) and perform preventive maintenance. The WPCs need to be monitoring the water points' performance to determine when there will be need for repairs and preventative maintenance. Despite the importance placed on these technical roles under the CBM framework, most committees' performances were rated as poor by users (Figure 5.5).

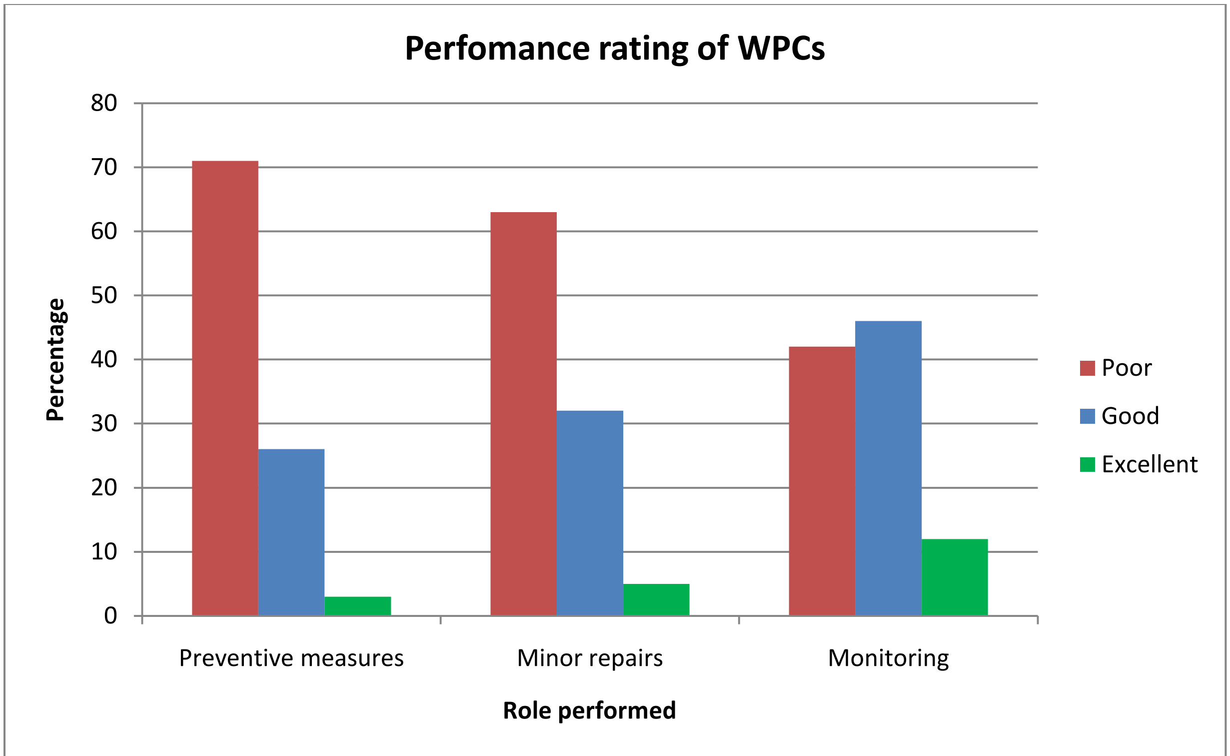

Figure 5.5: Performance rating of WPCs in technical roles by water users

Communities highlighted the inability of WPCs to perform minor repairs as contributing to frequent breakdowns. This resulted in communities contributing money to engage VPMs for what could be done for free by the WPCs. In cases where committees would have tried to perform minor repairs, the work was reported to be substandard in 40% of the studied cases. This was reported to be resulting in frequent breakdowns.

Preventive maintenance is when WPCs are supposed to dismantle a pump after every three months to check for any parts that could be tearing or wearing out so that they can be replaced (Harvey and Reed, 2007). WPCs were not performing preventive maintenance in 95% of the cases. The WPCs (65%) reported that there was no need to do preventive maintenance when a water point is functioning well. Fears of failing to put back pump parts correctly were also raised by 35% of the committees. Poor performance by WPCs in technical roles could be due to limited technical skills within the committees as discussed in Chapter Four. Technical skills within local institutions are important under CBM for water points to receive immediate attention when they have broken down. Such rapid responses reduce the downtime of water supply systems.

5.7 Roles and practices of development committees

Development committees found at community level are the Ward Development Committees (WADCOs) and the Village Development Committees (VIDCOs). Their purpose is to promote participation and provide the basis for a hierarchy of representative bodies at the village and ward levels, linking into district and then provincial structures. The duties of these committees include planning, monitoring and reporting on development projects. In theory, development needs of communities are prioritized firstly at village level and then at ward level before they are forwarded to the District Council (DC) where wards are represented by councillors.

The VIDCOs consist of an average of five villages and they are chaired by a village head. On average a village consists of 40-60 households. Members of the VIDCOs are village heads and secretaries of villages. On the other hand, WADCO members are the VIDCO members and the traditional leaders in a ward and it is chaired by a councilor (Constitution of Zimbabwe, 2013). According to the CBM implementation guide, these structures facilitate the development of water supply and sanitation plans at village and ward level for submission to the RDCs. However, these structures were only reported to be functioning in 15% of the studied villages and 21% of the studied wards. Considering the nature of membership of these structures, the committees existed in all the studied districts although the majority were not functioning. This resulted in councilors and other influential individuals developing water supply plans without the input of communities. In the few cases that had functioning WADCOs and VIDCOs, meetings were characterized by poor attendance. Community members (47%) indicated that they were not willing to attend the meetings because the meetings were usually politicized. Members of the structures were serving a dual purpose, firstly that of a development leader and secondly a political mobilizer. Results show that 50% of the key informants shared the view that the latter seemed to take precedence over the former. This makes the plans that are developed at local level not to be legitimized as they usually do not reflect the interest of people since they are mainly based on political interests.

According to the CBM framework WADCOs are supposed to be the central planning authority at ward level however, it was observed that in practice planning for ward developments is sometimes done at district level. The majority (72%) of the key informants highlighted that sometimes WADCOs work according to instructions they are given from the district party officials and the central government. The instructions are considered to be saving district and sometimes individual political interests defeating the role of WADCOs of being a channel for bottom up initiatives. The impact that politics has on CBM implementation within WADCOs and VIDCOs may necessitate the resuscitation of Ward Water and Sanitation Sub-Committees (WWSSCs) and Village Water and Sanitation Sub-Committees (VWSSCs) discussed in the next section.

5.8 Roles and practices of Village Water and Sanitation Sub-Committees (VWSSC) and Ward Water and Sanitation Sub-Committees (WWSSCs)

These are local level structures which were formed at the inception of CBM so that the DWSSC could link through to the water point level. According to the CBM framework the roles of these committees are to coordinate, monitor and report on water issues at their respective levels. The membership of the VWSSC consists of the chairpersons and secretaries of WPCs of all the water points in a village while for the WWSSC consist of the councilor, extension officers and Village Health Workers (VHWs) in a ward. During the time of the study these committees were absent in all the districts. Results show that the committees were set up after the inception of CBM, however they suffered a premature death due to duplication of roles between them and WADCOs and VIDCOs which were already in existence. Legally, the establishment of VIDCOs and WADCOs is through the Rural District Councils Act and the Traditional Leaders Act. The members of these structures are also constitutionally elected (GoZ, 2013). The legal backing that the WADCOs and VIDCOs have could explain their prominence in rural governance. Although the National Water Policy emphasizes the establishment of the DWSSC through which WWSSCs and VWSSCs are established, the absence of a legal provision on how they work with other structures at local level may hinder effective CBM implementation. Considering the impact that political interference has within the WADCOs and VIDCOs, as discussed in the previous section, WWSSCs and VWSSs may provide a better platform of water governance in the rural water sector since members of the committees are elected by communities. Although the sector's institutional framework recognizes the existence of these structures a legal backing is of importance.

5.9 Roles and practices of Health Committees

Health committees which participate in water supply development at community level are the Village Health Committees (VHCs) and the Ward Health Committees (WHCs). Members of the WHCs are the VHWs, government extension workers and local leaders such as chiefs and village heads. The WHC is chaired by the councilor of a ward and the secretary is the ward Environmental Health Technician (EHT) or a nurse in the ward. Across the three districts these committees were found to be present and functioning in all the wards. In 76% of the wards the active members of the WHC were the councilor, EHTs and the VHWs. Most (75%) of the committees were having regular meetings and minutes of the meetings and working plans were in place during the time of the study. According to the communities' rating, these committees were very active.

It was not conclusive why the health committees were found to be active in all the districts where other committees such as the WSSCs and the WADCOs are passive and have become redundant in most wards. Explanations provided during 80% of the FGDs seem to point towards the multiple task nature of the health committees. Unlike for example the WWSSCs and VWSSCs who would only meet for water issues, the health committees meet for a number of programmes such as HIV/ AIDS, tuberculosis, maternal health and others which are receiving funding from the government and NGOs. This increases their frequency of meeting and visibility in the communities. The committee members of health committees were benefiting from trainings, protective clothing and informal allowances from NGOs which act as incentives. Most EHTs (54%) had motorbikes, unlike some of the government extension workers. This increased the EHTs' mobility and visibility in their wards. Although the motorbikes were not provided under water supply projects, the EHTs use them to carry out water supply and sanitation work.

The efficacious role demonstrated by health committees in the implementation of CBM was noted in Ward 22 of Nyanga District. The VHWs performed the duties of WPCs among other duties. Due to the absence of WPCs at most (59%) of the water points in the ward, the VHWs were coordinating the management of water points during the time of the survey. The VHWs showed knowledge on the performance history of their water points, number of users of the water points and they were also collecting money for O&M. Although this may appear to be a potential source of conflict when WPCs are revived at the water points in question, it may also be an opportunity for linkages to be established when the roles of each structure are clearly spelt out.

5.10 Training requirements on CBM

Under the CBM framework, training that is supposed to be done is for WPCs, headwork builders and Village Pump Minders (VPMs). The training sessions are important as they enable structures and stakeholders in the rural water sector to effectively play their roles when implementing the CBM approach. The need and importance to impart skills to stakeholders is also highlighted in the Zimbabwe National Water Policy of 2013.

Water Point Committee Training

The diverse tasks done by WPCs have made their training to cover a number of topics which include organizational planning and financial management where issues of budgets and record keeping are taught. The committees are also trained in leadership roles and responsibilities where conflict resolution is a key aspect. On the technical aspect, the committees are trained on simple O&M of water points. A high proportion (54%) of the WPCs was not trained on the requirements of CBM. Furthermore, the time allocated for the training was in adequate in 65% of the cases as it was usually done in two days instead of the stipulated five days. In Chivi and Gwanda districts, 32% of the NGO reports showed that some trainings were done within a day. According to 75% of the NGO respondents, the limited time allocated to the training was due to financial and time constraints. This resulted in some topics being omitted or rushed through. A total of 55% of the training facilitators recommended that such short time allocations should be given to refresher trainings. For first time participants, it was echoed that the stipulated five days should be considered since some of the participants are non-technical and some are adults who need more time to understand the training content. This was worsened by the fact that, training manuals were only present in 36% of the studied wards. Where training manuals are not available more time is needed to give out the training material.

The inadequacy of CBM training was impacting negatively on a number of sustainability factors such as financial, institutional and technical as highlighted in 80% of the FGD sessions. Where WPCs were inadequately trained it was noted that their financial performance was poor (see Chapter Four). Inadequate training also adversely affected the technical capacity of WPCs which possibly explains why most of the committees were rated poor in performing technical roles as presented in Figure 5.5. The effect of inadequate training was also evident through the low confident WPC members as reported by 40% of the respondents. Lack of confidence within WPCs resulted in members frequently leaving the committees. Against the stipulated 7 members per committee, the mean number of membership was 6 in Gwanda and Chivi districts while it was 5 in Nyanga District. As highlighted by 61% of the WPC members, the gaps which existed in their institutions resulted in some duties not being executed.

Village Pump Minders (VPMs) training

According to the CBM framework training of VPMs should concentrate on repairs and maintenance of facilities, servicing schedules, record keeping and monitoring. Most (90%) of the VPM trainings were funded by NGOs while training facilitators were from government ministries and departments. The stipulated time for VPM trainings is two weeks, where four days are for the theory aspect while the rest of the days are for the practical component. However, it was noted that in practice the training is normally done in an average of 10 days which was said to be inadequate for trainees who will be learning most technical issues for the first time. According to 70% of the key informants interviewed at district and community levels, the limited training time was negatively impacting on the quality and adequacy of skills imparted to trainees. Quality of training was also affected by the absence of training manuals. Although 50% of the DDF facilitators indicated that they have training manuals, they were not given to trainees resulting in information being dictated. The majority (72%) of the VPM training facilitators highlighted that this led to limited information being given to the trainees. Providing VPM trainees with manuals is important as the manuals will be used for reference when repairing or maintaining water points.

Trained VPMs are supposed to be equipped with a toolbox to use when carrying out their duties. In the studied districts NGOs were giving one toolbox per two wards. In principle when a tool box is given, it is supposed to be kept at a central place by a village head. However, in practice the tool boxes were kept by councilors, chiefs and VPMs. It was noted that some villagers travel for more than 25 km to get a toolbox which was seen to be contributing to long down times for some water points. Complaints of misplaced and misused toolboxes were also raised. In some cases personal and political differences also affected the access to toolboxes. During the time of the study, 40% of the tool boxes did not have adequate tools which were reported to have been lost. This shows the fate that common property resources suffer from and hence the need for proper arrangements based on consensus to be put in place. Such arrangements will enable VPMs to easily access the tool boxes.

All VPMs who participated in the study did not have servicing schedules. Servicing schedules are important for preventive maintenance activities. The majority (61%) of the VPMs were also not carrying out routine monitoring on water points performance and they did not have the records on water points performance. Chivi District had 41% VPMs who were monitoring water points performance while Gwanda had 40% and Nyanga had 36%. The chi square test results ($\chi 2 = 14.10$, df=2, p= 0.172) show that there is no significant difference in VPMs monitoring water points performance across the districts. Results from KII highlighted that VPMs were only focusing on repairing water points after a break down. Lack of water points performance monitoring and absence of preventive maintenance by VPMs could explain why 44% of the studied water points did not have adequate parts (Chapter Four). The majority (84%) of the interviewed VPMs indicated that they were focusing on repairs since they are paid by user communities for repairing a water point unlike monitoring and carrying out preventive maintenance. However, it was revealed that under the three-tier system (see Chapter One) when VPMs were employed by DDF, they used to carry out all their expected roles. In this regard, the policy framework and the CBM framework may need to specify sustainable payment mechanisms for the VPMs so that they carry out all their duties.

Headwork construction and well sinking training

Training on headwork construction was never reported on in all the districts under study. It was noted that were head works where being constructed experienced builders were hired. A total of 60% of the KII highlighted that using builders who were already experienced was easier and less costly than training people without knowledge on building. The other reason that was also indicated by 77% of the NGO officers was that most NGO projects do not have a component on head work construction rendering the training uncommon. Although headwork construction was done by experienced builders, it was noted that the construction was done under the guidance of an EHT. This was done to guide the builder on the available options and appropriateness of the selected option. However, knowledge on rationale for building head works, options/types of head works and their appropriateness, material quantities required to build head works, operation and maintenance of head works is never imparted in the user communities.

Training of well sinkers was only done in Chivi District by a local NGO called Zvishavane Water Project (ZWP). Although deep and shallow wells were installed with hand pumps in other districts, it was noted that only already existing wells where used. No theory was done during the training due to the absence of manuals. The absence of the theory component and training manuals in the training of well sinkers negatively influenced the practices of the trainees. It was noted that the trainees were not exposed to issues of health and safety and use of protective clothing which are critical when sinking wells. This practice of giving inadequate training was seen to be reducing the trainees' confidence in well sinking. Results showed that 69% of the trained well sinkers highlighted that they were not practising although they were trained because the training was inadequate.

5.11 Discussion

The main aim of the chapter was to investigate if CBM is being implemented according to the guidelines provided in the CBM framework which are presented in Section 5.2. The chapter also investigated how the implementation of CBM by different stakeholders is influencing the sustainability of water supply systems. The key emerging issue within RDCs was limited funding to develop and maintain water supply systems. All the RDCs were not allocating the 15% of their annual budget towards WASH activities. When the RDCs were allocating funds of between 3-5% towards WASH, the funds were never released towards water development. It was also noticed that all districts did not have revolving funds which is stipulated in the CBM framework. The failure by the RDCs to fulfil their financial policy obligations affects the implementation of CBM as communities in rural areas of Zimbabwe lack the financial capacity to maintain and develop water supply systems. These results concur with findings by Hoko et al. (2009) in their study in Mt Darwin District of Zimbabwe. The RDCs' financial performance questions their capacity as authorities of water supply and sanitation in rural areas. While they are well positioned to involve rural communities in development projects, their long history of limited capital support, limited human capacity, poor financial base, and the tendency to make decisions on the basis of politics rather than pragmatism, threatens sustainability. The RDCs' designation in the rural water sector then challenges them to increase their human, technical and financial capacity to improve the implementation of the CBM approach.

Findings also showed that the RDCs do not provide funds for water development activities and depend on NGOs to fund these activities. This works against the government's policy where donors are supposed to be complementing its effort. Although a number of donors are currently funding water supply projects, continued dependence has perpetuated the vulnerability of the sector as donor projects have a lifespan and come to an end. RDCs dependence on donor funding is not unique to Zimbabwe as this was also noted in Zambia by Chowns (2014). In this regard, the RDCs have to consider continuous financing mechanisms as the study findings show that communities are not able to fund the development and maintenance of water points on their own.

NGOs were also not implementing the CBM approach according to the set guidelines. Although NGOs are the most resourced institutions at district level, their financial resources were strictly directed to certain interventions. Their budgets were mainly directed to the implementation and rehabilitation of infrastructure rather than the necessary CBM training. This is despite the fact that, implementation of water infrastructure without local level institutions with technical, managerial and financial capacity negatively impacts CBM (Harvey & Reed 2004). The NGOs were also reported to be implementing their projects in a rushed manner even when the projects are not emergency responses, thereby omitting some of the CBM activities. This resulted in passive participation of communities which works against the CBM approach. These results concur with Mugumya (2013) who concluded that poor implementation of CBM in some parts of Tanzania was due to skewed budgets which did not support activities such as community mobilization and trainings, favouring the implementation of new facilities. Mugumya (2013) also blamed the rushed implementation of projects by NGOs to be contributing to unsustainable water supply systems. These findings show that although NGOs are important stakeholders in rural development especially in the rural water sector, their projects have to be aligned to government's programmes. Strong coordinating institutions at all levels will then be of importance to coordinate and provide monitoring for NGOs to implement their programmes in line with the existing government policies.

The roles of the DWSSC were affected by lack of financial resources within government departments. Limited financial resources resulted in government ministries carrying out irregular monitoring on how CBM is implemented by NGOs and community level institutions. Where monitoring was not done, NGOs had a tendency of not implementing CBM according to the CBM framework. This result resonates well with findings by Kadeti (2009) who concluded that lack of monitoring by government institutions resulted in different forms of CBM being implemented in India as some key principles of the approach were not followed. Partial implementation of CBM has been blamed for unsustainable water supply services as some key principles of the approach may be omitted (Quin et al. 2011).

Lack of financial resources has also diminished the capacity of national institutions to update their data bases on water supply coverage and water point functionality. This has rendered the quality of information at the district level inadequate and unreliable. This is in agreement with Ngopa (2012) who concluded that limited availability of equipment due to lack of financial resources, contributed to unreliable data bases in the water sector of Uganda. The availability of an updated and reliable database is of great importance as this provides strategic direction to the sector. There is also a need to develop standard monitoring tools at district level to enable the collection of data which is consistent with the sector objectives. Since the data that is collected at district level is submitted to the national level, this facilitates planning based on actual findings.

The mismatch between theory and practice in CBM implementation at community level was emanating from practices by the district institutions. Lack of financial resources within district institutions influenced the level and frequency of technical and managerial training which was offered to community institutions. This affected the implementation of CBM as the communities who are expected to operate and maintain water supply systems under CBM do not have the adequate skills to do so. This result shows that although the CBM guidelines are technically well designed, this is proving to be of limited benefit since the implementation is weak. These results concur with findings by Ngopa (2012) where lack of financial resources led to poor implementation of community management approaches in some parts of Tanzania. Brinkerhoff & Crosby (2002) also argued that no matter how well frameworks and policies are formulated, there is need for financial resources for the frameworks and policies to achieve intended benefits.

At the community level, it was also noted that the practice of VPM of not carrying out technical duties that are not paid for has a negative impact on sustainability. This shows that under CBM voluntarism may work to a certain extent thus options of professionalizing CBM by paying services which are critical for sustainable management of water supply facilities may need to be considered (Moriarty et al. 2013). These findings reflect on the difficulty and contextual realities in implementing CBM in resource limited countries, questioning the adoption of the approach as a one-size-fit-all in the rural water sector.

Political influence was also found to be impacting on how CBM is implemented at the community level. Results in Section 5.7 show how planning at local level is influenced by political interests. This shows that despite the government's legal commitments to decentralization, in practice power continues to reside in higher administrative units and individuals. Such a practice is a reflection of how CBM is not being implemented according to its guidelines which has negative impacts on sustainability of water supply systems.

Contextualizing the Sustainable Livelihoods Framework, these results show how institutions, policies and frameworks influence livelihoods of rural communities. The results show how implementation of CBM as a policy prescription impacts on the social, financial, institutional and technical capacity of community institutions and the overall sustainability of water supply systems.

5.12 Summary

The chapter investigated how CBM is being implemented by different stakeholders in the rural water sector and how its implementation is influencing the sustainability of water supply systems. The RDCs were not implementing CBM following procedures prescribed by NAC. This was mainly due to lack of financial resources. The discrepancy in implementing CBM by the RDCs was due to their dependence on NGOs to fund WASH activities. On the other hand, NGOs were not following some of the CBM steps which impacted on the level of participation of user communities. Budgets of NGOs are mainly directed at the installation of new facilities, with minimal funds for the training on water point management and maintenance. The DWSSC was not carrying out regular monitoring on CBM implementation which resulted in some NGOs and community structures not following the CBM implementation guide.

The challenges in CBM implementation faced within the community institutions were emanating from the district level institutions. The local institutions were not receiving adequate support which impacted on their capacity to implement CBM. Political influence was also negatively influencing the implementation of CBM by development committees. The dichotomy of theory and practice in CBM implementation was impacting on sustainability. There is need therefore, for effective monitoring mechanisms to be developed for the approach to be implemented according to its prescriptions.

6 INFLUENCE OF MULTIPLE USES OF WATER ON THE SUSTAINABILITY OF WATER SUPPLY SYSTEMS

6.1 Introduction

Strategies used by NGOs in implementing and managing rural water supply projects have gained importance in Zimbabwe (Makoni & Smits 2007). In an effort to improve rural livelihoods by tackling the multiple dimensions of poverty, most NGOs have combined the provision of water supply with community gardening and constructing water troughs for livestock. Community gardens in this study are defined as a piece of public land that is protected, and divided into smaller plots which are allocated to and utilized by individual households. The households mainly grow vegetables for both household consumption and for sale. The use of drinking water sources for multiple uses is supported by the Zimbabwe National Water Policy of 2013 as it prescribes that, "Where water supply from a water point is abundant enough to permit productive uses, rural WASH programs will be integrated with productive uses such as irrigation to assist in raising funds for management of water points". From the policy perspective, the use of drinking water points for multiple uses aims to improve the management of the water points through raising funds for O&M. However, the policy highlights that the capacity of a water point to provide adequate water has to be considered for communities not to be deprived of drinking water.

The use of drinking water supply systems for productive uses is not a new practice in Zimbabwe and the world over (Katsi et al. 2007; Makoni & Smits, 2007; Smits et al. 2010a). Communities have been using water sources universally for domestic and productive purposes at both household and community levels since time immemorial due to their multiple water needs (Van Koppen et al. 2006). The recognition of people's multiple water needs and the increased attention to the provision of water supply services to meet both domestic and productive needs resulted in the development of the concept of Multiple Water Use Systems (MUS) (Adank et al 2008; Hanjra & Quereshi 2010). Although the concept has been defined differently by various authors, (Van Koppen et al. 2006; Adank et al 2008; Smits et al. 2010a; Fielmua & Mwingyine, 2015) in the context of this study MUS is when a drinking water system is used for both domestic and productive uses. As explained in Chapter One, productive uses in this study are the non-domestic uses such as livestock watering and gardening while domestic uses are the consumptive uses (drinking and cooking) and hygiene uses (washing, cleaning and bathing).

Multiple use of water is practiced even without the need for new technologies. Smits et al. (2010b) in their study of eight countries in Africa, Asia and Latin America concluded that multiple uses of water can be based on existing technologies. This has been noted where domestic water supply systems have been used for small scale productive activities such as gardening, livestock watering, and processing of agricultural products (Lovewell, 2000; Katsi et al. 2007). The same has also been noted where productive sources of water are used for domestic purposes such as drinking and washing (Meinzen-Dick 1997; Boelee et al. 1999; Renwick 2001). However, Van Koppen et al. (2006) contested that designing infrastructural add-ons is indispensable for sustainability of systems to be achieved. Where water supply systems would have been implemented for domestic uses, then productive ones will be added on, these are referred to as "domestic-plus" systems (Van Koppen et al. 2006). In domestic-plus systems there is a need to increase the capacity of abstraction, storage and delivery infrastructure by augmenting the diameters of pipes (Van Koppen et al. 2014). Another common add-on has been the construction of water troughs (Makoni & Smits 2007). The absence of such add-ons results in breaking down of systems due to excessive use (Moriarty et al. 2004).

Using drinking water sources for productive uses such as community gardening and livestock watering reduced poverty and widened livelihood options (Boelee et al. 1999; Smits et al. 2010b). Where communities will be selling their garden produce and livestock, studies have shown that financial contributions towards O&M of water supply systems is enhanced thereby positively influencing financial sustainability (Boelee et al. 1999; *Renwick 2001;* Fielmua & Mwingyine 2015). However Smits et al. (2010b) contested this through his findings in Honduras where multiple uses of water did not automatically lead to higher levels of fee collection for O&M of water supply systems. Instead, multiple uses of water had a negative influence on sustainability due to poor financial performance. Since financial performance has always been a challenge where water supply services are managed by communities, it is critical to understand how this can be improved by using the drinking water sources for productive purposes.

While the benefits of community gardening on rural as well as urban households is well documented (Chitongo, 2013; Lovewell 2014), the impacts of gardening on the sustainability of water supply systems where multiple uses of water is practiced has not been adequately examined. Documented studies on multiple uses of water have mainly focused on the impacts of the practice on livelihoods and policy issues (Van Koppen et al. 2006; Makoni & Smits 2007, Smits et al. 2010b; Fielmua & Mwingyine 2015). It is in this context that this chapter seeks to explore how multiple uses of water, in this case community gardening and livestock watering as productive uses combined with domestic uses influence sustainability of water supply systems. The specific questions that the chapter seeks to answer are:

1. Are there differences in sustainability performance by water points with community gardens and those without the gardens?
2. Are there differences in sustainability performance of water points used for livestock drinking and those which are used for domestic purposes only?
3. Are there differences in sustainability performance of water points before and after community gardens were implemented?

6.2 Methodology

Sampling, data collection and analysis methods which were used for this chapter have been explained in Chapter Three. As explained in Section 3.3 stratified sampling was used to select water points used for multiple uses and those used for domestic purposes only. To answer the objective of this chapter, 164 water points were targeted, where half of them had multiple uses and the other half were used for domestic purposes only (Table 3.2). Data was collected using household and WPC questionnaires, KIIs, FGDs and document analysis (see Section 3.4). Qualitative data was analyzed using the thematic analysis (see Section 3.6). Descriptive statistics, chi square test, independent samples t-test and the paired samples t-test were used to analyze quantitative data (Section 3.5). The formulas for the independent samples t-test and the paired samples t-test are explained in Sections 3.5.4 and 3.5.5 respectively.

The independent samples t-test was used to examine whether there were differences between the water points used for multiple uses and those used for domestic purposes only based on the institutional, technical, social and financial factors. The average sustainability scores of the factors which were used for the independent samples t-test were calculated using the methods explained in Sections 3.5.2. The specific hypotheses which were tested for the sustainability factors are as follows:

Hypothesis 1

H_0: There is no difference in the average financial scores of water points used for multiple uses and those used for domestic purposes only.

H_1: There is a difference in the average financial scores of water points used for multiple uses and those used for domestic purposes only.

Hypotheses 2

H_0: There is no difference in the average technical scores of water points used for multiple uses and those used for domestic purposes only.

H_1: There is a difference in the average technical scores of water points used for multiple uses and those used for domestic purposes only.

Hypotheses 3

H_0: There is no difference in the average institutional scores of water points used for multiple uses and those used for domestic purposes only.

H_1: There is a difference in the average institutional scores of water points used for multiple uses and those used for domestic purposes only.

Hypotheses 4

H_0: There is no difference in the average social scores of water points used for multiple uses and those used for domestic purposes only.

H_1: There is a difference in the average social scores of water points used for multiple uses and those used for domestic purposes only.

The hypotheses were also set to examine the differences in sustainability performance for the following variables:

- Amount of O&M fund present at the time of the study
- Number of households making financial contributions per year
- Number of households attending community water management meetings per session
- Number of community water management meetings held per year
- Number of WPC meetings held per year
- Frequency of making financial contributions per year
- Maintenance frequency per year
- Number of water use conflicts per month
- The mean downtime period
- Frequency of water point breakdowns per year
- Number of vulnerable households participating in O&M per year

The paired samples t-test was used to detect changes in factor performance before and after the implementation of community gardens. An example of the hypotheses which were tested using the paired samples t-test is:

H_0: There is no difference in the frequency of making financial contributions towards O&M between the pre-garden and the during-garden periods.
H_1: There is a difference in the frequency of making financial contributions towards O&M between the pre-garden and the during-garden periods.

The other hypotheses were set to examine whether there were differences between the two periods based on the following variables:

- Number of community water management meetings held per year
- Number of households monitoring water points' performance per month

- Number of households making financial contributions per year
- Number of households attending water management meetings per session
- Number of men attending water management meetings per session
- Number of vulnerable households participating in O&M per year
- Number of water point breakdowns per year
- Frequency of water use conflicts per month

6.3 Socio-economic status of households

A total of 300 households participated in the study across the three districts. The socio-economic status of the households is shown in Table 6.1.

Table 6.1: Socio-economic status of households in Chivi District

Chivi District				
Variable	**Minimum**	**Maximum**	**Mean**	**S. D**
Age (years)	20	74	39.32	5.88
Family size (persons)	1	11	5.23	1.75
Monthly income	USD$10	USD$420	USD$38	15.54
Nyanga District				
Age (years)	21	70	38.65	33.86
Family size (persons)	1	10	4.82	1.32
Monthly income	USD$16	USD$400	USD$61	52.52
Gwanda District				
Age (years)	19	68	38.54	23.41
Family size (persons)	2	14	4.58	1.81
Monthly income	USD$21	USD$500	USD$54	33.21

The family sizes across the districts ranged between 1 and 14 and the means for the different districts were 5.23 in Chivi, 4.58 in Gwanda and 4.82 in Nyanga. The chi square test results (χ^2

=4.210, df=2, p= 0.102) show that there is no significant difference in the family sizes across the three districts. These results are in line with the national census results (ZimStat 2013). The level of education attained by the respondents across the districts did not vary, where secondary level was the mode. Tertiary education was the highest level of education attained by the respondents and it was attained by 10% of them. The lowest level of education attained by the respondents was primary education which was attained by 28%. The chi square test results (χ^2 =6.591, df=4, p= 0.271) show that there is no significant difference in the level of education of the respondents across the districts. The literacy level of the respondents was established to be 95%. The high level of literacy shown by these results concur with the UN (2015), which showed that Zimbabwe has a literacy level of 86.5% which is one of the highest rates recorded in the continent.

The majority (90%) of the respondents were not employed in the three districts. Those who were employed reported to be formally employed (2%), self employed (3%) and informally employed (5%). High levels of unemployment rate are consistent with the numerous national reports on the prevailing unemployment rate in Zimbabwe (ZimStat 2016). Due to these high levels of unemployment, the households in the study districts had low levels of income which are below the national poverty datum line of $481 for a family of five (ZimStat 2016). Chivi District had the least average household monthly income of $30 while Gwanda had $40 and Nyanga had $44. The chi square test results (χ^2 =12.54, df=4, p= 0.013) show that there is a significant difference in the monthly average income across the three districts.

The main source of income in the three districts was crop production. In Nyanga District, gardening was the second highest income source contributing 25% of the total household income. In Gwanda District, the second highest source of income was livestock farming followed by gold panning, while in Chivi District, remittances were the second source of income followed by gardening. Although the respondents showed that they had several sources of income, the sources contributed very little towards the total household income, living the households susceptible to poverty.

6.4 Access to water by households

The main domestic water sources are presented in Chapter 4 (Table 4.8). These water sources are mainly communally-owned and managed (92%). A low percentage (8%) of the respondents used individual water sources in Nyanga District. The most important communal water sources were boreholes and deep wells. Some (5%) of the individual water sources were shared by a number of families and they were referred to as individual sources as they were developed and are maintained by individual owners. Some (6%) households using individual water sources were also using communal water sources during the dry season when their shallow wells dry up.

Women and girls were the main water collectors in the households (Table 6.4). The chi square test shows no significant difference in who mainly collects water in the three districts (χ^2 =2.341, df=4, p= 0.152). The main mode of transporting water was by individuals carrying water containers on their heads (Table 6.2). Wheel barrows and carts drawn by animals were commonly used where households travel more than 2 kilometres to fetch water, and where men will be fetching water. The burden of collecting water was worsened by long distances. Table 6.2 shows that some households took more than one and a half hours for a round trip to collect water. Only an average of 16% of the households took less than 30 minutes for a round trip which clearly shows the magnitude of the burden that most women and girls have when accessing water for domestic purposes. Across the districts only 11% of the households travel less than 500m to collect water while 47% travel more than a kilometre.

Table 6.2: Water collection and consumption by households

District	Chivi	Gwanda	Nyanga
	%	%	%
Who usually collects water in the household			
Adult woman (age 15+ years)	65	63	69
Adult man (age 15 + years)	2	3	2
Female child (under 15years)	28	30	26
Male child (under 15 years)	5	4	3
Distance travelled to fetch water			
Less than 500m	6	7	19
500m-1km	40	36	42
1km-1.5km	27	21	26
1.5km-2km	21	17	10
More than 2km	6	9	3
Time taken for a round trip to collect water			
Less than 30mins	12	14	22
30mins-1hr	51	45	54
1hr-1hr 30mins	19	23	12
1hr 30mins-2hrs	14	15	9
More than 2hrs	4	3	2
Water consumption per person/day			
Less than 15 litres	10	13	8
15-20litres	20	43	27
20-25 litres	43	27	40
25-30 litres	19	10	11
Above 30litres	8	7	14
Total	**100%**	**100%**	**100%**

The amount of water used by individuals per day ranged from 10-35 litres (Table 6.2). The average household water consumption pattern depended on the family size, time taken for a round trip and the level of engagement in productive activities such as gardening. A total of 33% of the respondents indicated that they make 2 trips while 60% make more than 2 trips per day collecting water when using 20litre buckets which were the most commonly used water collecting containers. The remaining 7% who were making a single trip were using wheel barrows or carts drawn by animals.

6.5 Water points used for community gardening and livestock watering

The number of water points used for community gardening and livestock watering studied per district are shown in Table 6.3.

Table 6.3: Number of studied water points used for community gardening and livestock drinking per district

Description	Chivi	Gwanda	Nyanga	Total
Number of water points used for community gardening	11	4	15	30
Number of water points used for livestock watering	5	16	3	24
Number of water points used for community gardening and livestock watering	0	0	2	2
Number of water points used for domestic purposes only	16	20	16	52

Table 6.3 shows that Nyanga District had 16 water points with community gardens while Chivi had 11 and Gwanda had 4. Notably, Gwanda District had the highest number (16) of water points used for livestock drinking and Chivi and Nyanga had 5 and 3, respectively. The high number of water points used for livestock drinking in Gwanda District is attributed to the dominance of livestock farming. On the other hand, community gardening using drinking water sources was more common than watering livestock in Chivi and Nyanga districts. Although an average of 85% of the water points in Chivi and Nyanga districts had water troughs, they were not being used due to the existence of alternative water sources for watering livestock. Most water points (90%) with water troughs were protected to prevent animals from soiling the surroundings as shown in Figure 6.1.

Figure 6.1: Fenced water point with a water trough in Gwanda District

As explained in Section 6.1 land is communally owned in community gardens and each farmer has his/her allocation within the large garden area. Figure 6.2 shows a garden committee member pegging beds to be allocated to individual households.

Figure 6.2: Garden committee member pegging beds in a community garden in Nyanga District

The number of households within community gardens ranged between 12 and 28 across the districts (Table 6.4)

Table 6.4: Characteristics of community gardens

District	**Chivi**	**Nyanga**	**Gwanda**
Average number of households per garden	19	23	14
Average size of plots per household	0.05 hectares	0.06 hectares	0.035 hectares
Main crops grown	Leaf vegetables, tomatoes, peas, sweet potatoes, onions, carrots, maize	Leaf vegetables, tomatoes, peas, sweet potatoes, butternut, beans, onions, carrots, maize	Leaf vegetables, tomatoes, onions, carrots, maize

Table 6.4 shows that Nyanga District had an average of 23 households in each garden while Chivi and Gwanda districts had 19 and 14 respectively. Although water for domestic purposes was being shared by households from different villages as discussed in Chapter Four, this was not the case with water for productive uses as community garden farmers were from the village where a garden would have been implemented. It was noted that males constituted 31% of the farmers. Interview results showed that garden activities were referred to as women's and children's responsibilities by 68% of the respondents. However, some garden committees reported that men have been joining community gardening since 2014 due to the harsh economic environment prevailing in the country. It was also noted that, across the districts there were some community gardens (20%) which were implemented for vulnerable households such as those taking care of HIV and AIDS patients, orphans and the physically-challenged as well as child-headed, elderly-headed and female-headed households. These gardens had 92% women farmers.

The size of land allocated per farmer was mainly determined by the number of garden farmers and size of the available land. The land sizes ranged between 0.035 hectares per farmer in Gwanda to 0.06 in Nyanga. The main crops grown in the gardens were almost the same across the districts as shown in Table 6.4. Crops such as tomatoes, onions and beans were the most preferred due to their high cash value as compared to leaf vegetables. Garden farmers were growing an average of three crops per year. A total of 95% of the interviewed garden farmers sell the surplus of their garden produce. Income from selling garden produce was contributing between 20-60% of the households' monthly income at the time of the study. These percentages are higher than those found in other studies (Lovewell 2000; Mikhal 2010). The high percentages in the study area could be due to high poverty and unemployment levels resulting in households maximising on gardening as a source of income.

6.6 Influence of multiple uses of water on sustainability

The sustainability classification used in this chapter is the same as the one used in Chapter Four. As explained in Chapter Three, water points with a sustainability score above 75% are classified as highly sustainable, those with 50% - 75% are sustainable, 25% - 49% are partially sustainable and those with below 25% are not sustainable. The results show a major difference in the sustainability of water points used for multiple uses (gardening and livestock drinking) and those used for domestic uses only as shown in Figure 6.3.

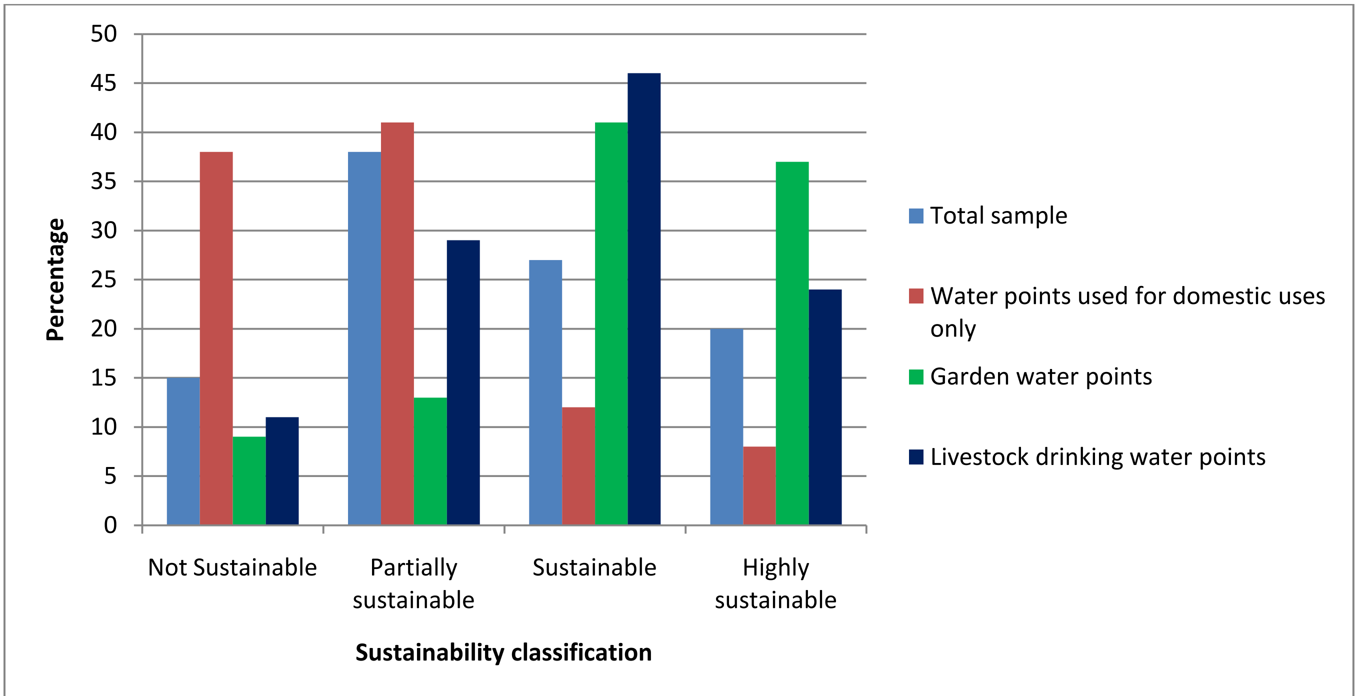

Figure 6.3: Sustainability classification of water points used for multiple uses and those used for domestic purposes only

Figure 6.3 shows that 79% of the water points used for domestic purposes only were in the Not Sustainable and Partially Sustainable categories, while water points used for community gardening had 22% and those used for livestock drinking had 40% in these categories. An independent samples t-test was done to examine whether there were significant differences in the sustainability scores between water points used for domestic purposes only and those used for community gardening. The results (t= -4.684, p= 0.000) show that there is a significant difference in the sustainability scores between the two groups. The test also showed a significant difference in the sustainability scores of water points used for watering livestock and those used for domestic purposes only (t=-2.565, p = 0.012). The impacts of community gardening and livestock watering on sustainability factors are presented in the following sections.

6.6.1 Influence of community gardens on sustainability of water supply systems

The results of the independent sample t-test show differences in performance between water points used for community gardening and those used for domestic purposes only in financial, social, technical and institutional factors. Variations were also shown in variables tested under each factor (Table 6.5).

Table 6.5: Independent samples t-test results for water points used for community gardening

	Water points used for community gardening	**Water points used for domestic purposes only**	***t*-value**	**p-value**
Factors				
Financial (%)	87.7	43.6	6.133	0.000
Technical (%)	66.8	48.2	4.602	0.000
Social (%)	69.4	44.5	4.185	0.000
Institutional (%)	78.1	42.7	5.136	0.000
Variables investigated				
Number of community water management meetings/year	9.34	3.02	10.992	0.000
Number of WPC meetings/year	9.71	3.19	8.503	0.000
Number of households attending meetings / session	24.02	20.28	2.684	0.010
Number of households making financial contributions / year	20.93	14.37	5.705	0.000
Number of vulnerable households participating in O& M / year	4.76	2.26	6.703	0.000
Amount in O&M fund	23.63	3.51	10.565	0.000
Maintenance frequency/year	4.74	2.03	3.482	0.001
Frequency of water use conflicts/month	3.73	2.14	5.045	0.020
Frequency of breakdowns / year	4.84	2.09	6.328	0.000

Influence of community gardens on financial factors

Table 6.5 shows that there was a significant difference in the financial performance of water points used for community gardening and those used for domestic purposes only (t= 6.133, p = 0.000). The mean financial score for water points used for community gardening was 87.7% compared to 43.6% for those used for domestic purposes. The null hypothesis that there is no difference in the average financial scores between the water points used for community gardening and those used for domestic purposes only was rejected. The variables which were tested under the financial factor showed significant differences between the two groups. The difference in the number of households making financial contributions per year was statistically significant ($p = 0.000$) between the two groups with a t value of 5.705. Most (81%) of the households using water points which are used for community gardening were contributing towards O&M using the money they were earning from selling garden produce. According to the garden constitutions, all garden farmers were expected to contribute towards O&M of water points.

Users of water points used for community gardening were making financial contributions towards O&M funds on monthly basis compared to those who use water points used for domestic purposes only who were contributing after a breakdown. T-test results showed a significant difference in the frequency of making financial contributions between the two groups ($t= 7.829$, $p=0.000$). The difference in frequencies of making financial contributions explain why the downtime between the two groups was also statistically significant ($t= 7.979$, $p=0.001$). The mode of the downtime for water points used for community gardening was one week while for water points used for domestic purposes only was two months. Results from 85% of the key informants showed that garden farmers made efforts to have short downtimes due to absence of alternative water sources for their crops. Most water points (96%) used for community gardening had an O&M fund compared to 21% for those used for domestic purposes only. The difference in the existence of the fund between the two groups was statistically significant ($\chi^2=6.721$, $p<0.01$). The presence of rules on fee collection and the frequency of making financial contributions contributed to the higher amounts ($21) of O&M funds for water points used for community gardening as compared to $3 for water points used for domestic purposes only. The null hypothesis that there is no difference on the average amount of O&M funds between water points used for community gardening and those used for domestic purposes only is rejected.

Influence of community gardens on social factors

The social factor constituted of the number of vulnerable households participating in O&M per year, the number of households attending water management meetings per session and the number of households making financial contributions per year. As presented in Table 6.7, there was a significant difference in the social factor scores of water points used for community gardening and those used for domestic purposes only ($t= 4.185$, $p = 0.000$). The average score for water points used for community gardening was 64.4% while that of water points used for domestic purposes was 48.5%. The null hypothesis that there is no difference in the average social scores between water points used for community gardening and those used for domestic purposes only is rejected. The number of community water management meetings held per year was 11 per year for water points used for community gardening compared to 2 meetings conducted for water points used for domestic purposes only over the same period. This result rejects the null hypothesis that there is no difference in the average number of community water management meetings held between the two groups. Table 6.5 shows that an average of 24 households attend meetings where water points are used for community gardening as compared to 20 in the other group. This shows the influence that community gardening has on the frequency of meetings and attendance. The independent samples t-test result ($t= 2.684$, $p= 0.010$) shows a significant difference in the average number of households who attend water management meetings between the two groups. Community gardening also had an influence on the number of vulnerable households participating in O&M as the difference is statistically significant between the two groups ($t= 6.703$, $p= 0.000$).

Water points used for community gardening had more water use conflicts (3.73) per month than those used for domestic purposes only (2.14). The independent samples t-test show a significant difference in the number of conflicts recorded per month between the two groups ($t= 5.045$, $p=0.000$). Water use conflicts at water points used for gardening were mainly between garden farmers and non-garden farmers. It was reported that non-garden farmers were sometimes refusing to make financial contributions, attributing breakdowns of water points to the use of water points for gardening. Interview results show that some community members (59%) perceived that using water points for gardening puts pressure on the infrastructure resulting in physical breakdowns. Conflicts between garden farmers and non-garden farmers were also experienced during the dry season when garden farmers continue to water their crops depriving community members of water for domestic purposes. In Chivi District conflicts between two villages (Madhaki and Tagwireyi) resulted in a water point that was being used for community gardening to be abandoned.

Influence of community gardens on technical factors

The technical factors constituted of the maintenance and breakdown frequencies. Table 6.5 shows that the average technical factor score for water points used for gardening was 66.8% while that for water points used for domestic purposes only was 48.2%. The independent samples t-test results ($t=4.602$, $p =0.000$) show a significant difference in the average technical scores between the two groups resulting in the rejection of the null hypothesis that there is no difference in the average technical scores of water points between the two groups. Maintenance frequency is one of the technical variables which was analyzed and the independent samples t-test showed a significant difference in maintenance frequency between water points used for community gardening and those used for domestic purposes only ($t=3.482$, $p=0.001$). The frequency of maintaining water points was high at water points used for community gardening due to the presence of maintenance committees. It was also noted that 93% of the water points used for community gardening were functioning during the study as compared to 56% used for domestic purposes only.

Water points used for community gardening had more break downs per year than those used for domestic purposes only. The average breakdown frequency of water points used for community gardening was 4.84 times per year as compared to 2.09 times for those used for domestic purposes only. The independent samples t-test shows a significant difference in the breakdown frequency of water points in the two groups ($t= 6.328$, $p= 000$). Therefore, the null hypothesis that there is no difference in the average breakdown frequency of water points between the two groups is rejected. This result shows that community gardening has a negative influence on sustainability as it increases the frequency of breakdowns. FGD results from 54% of the sessions showed that breakdowns were high at water points used for community gardening during the dry season when the demand for water by garden farmers is high. Measures to rapidly attend to breakdowns thus need to be put in place so that communities are not deprived of accessing drinking water.

Influence of community gardens on institutional factors

Water points used for community gardening had an average institutional score of 78.1% while those used for domestic purposes only had 42.7%. The independent samples t-test results showed a significant difference in the average institutional scores between the two groups (t= 5.136, p= 0.000) thus rejecting the null hypothesis testing the institutional factor. All the water points used for community gardening had functioning WPCs while 61% of the water points used for domestic purposes only had such committees. The chi square test showed a significant difference in the functionality of WPCs between the two groups (χ^2=10.09, p<0.01).

6.6.2 Sustainability performance of water points at the pre-garden and during-garden periods

A paired samples t-test was done to investigate if there were differences in the performance of sustainability factors between the pre-garden and during-garden periods. The test was done for water points which were initially implemented without gardens and had gardens during time of the study. The variables which were analyzed are those which had available data during the study. As discussed in Section 6.2, these variables are number of households monitoring a water point performance per year, number of households attending water management meetings per session, number of households contributing towards operation and maintenance per year, number of men attending water management meetings per session, number of vulnerable households participating in operation and maintenance, number of water management meetings conducted per year, frequency of water use conflicts per month and the frequency of water point breakdowns per year. The results for the paired samples t-test are shown in Table 6.6 and these were used to test the hypotheses in Section 6.2.

Table 6.6: Paired samples t-test results for the pre-garden and during-garden periods for water points used for community gardening

Variables	**Mean before garden implementation**	**Mean after garden implementation**	***t*-value**	**p- value**
Number of households monitoring water point performance / year	14	20	-28.954	0.002
Number of households contributing O&M funds / year	13	22	-26.066	0.000
Number of water management meetings / year	3	11	-17.945	0.000
Number of households attending meetings / session	20	27	-22.725	0.001
Number of men attending water meetings / session	6	11	-16.756	0.010
Number of vulnerable households participating in operation and maintenance	3	6	-11.123	0.000
Number of breakdowns / year	2	5	-12.461	0.000
Frequency of water use conflicts / month	1	4	-8.092	0.000

The number of households monitoring water point performance increased from an average of 14 to 20 between the pre-garden and during-garden periods. Paired samples t-test results (t = -28.954, p= 0.002) show a significant difference in the number of households monitoring water point performance between the two periods. Results also showed that households attending water management meetings also increased from 20 in the pre-garden period to 27 after gardens were established with t=-32.725, and p=0.001. The average number of households making financial contributions in the pre garden period was 13 and it increased to 22 after gardens were established (t=-26.066, p=0.000). The null hypotheses testing the differences in the means of variables discussed above between the pre-garden and the during-garden periods were rejected.

Most households (58%) who were not participating in water management before gardens were implemented reported to have started participating in water point management when they became garden farmers. Gardens being a source of livelihoods and income diversification are of great importance to the communities, hence their participation in the management and maintenance of the water sources used to water the gardens. Participation of vulnerable households in O&M increased between the two periods ($t=-11.123$, $p=0.000$). Participation of vulnerable households was mainly influenced by the establishment of community gardens targeting such households. It was noted that vulnerable households were being given garden inputs by NGOs and 90% of them were selling their garden surplus, increasing their capacity to make financial contributions towards O&M.

The implementation of gardens also had an impact on the average number of water management meetings as it increased from 3 in the pre-garden period to 11 after gardens were established. The paired samples t-test show a significant difference in the average number of meetings held between the two periods ($t=-17.945$, $p=0.000$) hence the rejection of the null hypothesis on frequency of water management meetings. Results also showed that, the average number of men attending water management meetings increased from 6 in the pre-garden period to 11 after gardens were established ($t=-6.756$, $p=0.010$). According to 71% of the key informants, gardening as a productive activity attracted the participation of more men in the management of water points. Respondents (27%) indicated that the participation of men is crucial when muscular activities such as technical repairs and maintenance are being carried out. This impacted positively on sustainability of water points as water users may not have to hire and pay pump mechanics to do minor repairs and maintenance as it is done by male garden farmers.

The implementation of gardens also improved the frequency of making financial contributions. Financial contributions were made on a monthly basis after the implementation of gardens as compared to the pre-garden period when contributions were made after a breakdown. The difference in the frequency of making financial contributions was significantly different between the two periods ($t=12.677$, $p=0.010$). Making financial contributions towards O&M resulted in the establishment of O&M funds. This contributed to the reduced downtime of water points from an average of two months during the pre-garden period to 5 days after gardens were established, and the independent samples t-test shows a significant difference in the downtime period between the two periods (t=6.549, p=0.004).

Frequency of water point break downs and conflicts on water use increased between the two periods. Unlike the other factors discussed earlier in this section, the increase in frequency of water point breakdowns and water use conflicts have a negative impact on sustainability. The average number of breakdowns increased from 2 per year in the pre-garden period to 5 per year after the implementation of gardens. The independent samples t-test showed a significant difference in the frequency of water point breakdowns (t= -12.017, p= 0.000). As shown in Table 6.6, the average number of water use conflicts increased from 1 per month in the pre-garden period to 4 during the same period after the implementation of gardens. Statistically, the difference between the two periods is significant (t= -8.092, p= 0.000). These t- test results therefore resulted in the rejection of the null hypotheses testing the two variables.

6.6.3 Influence of livestock watering on sustainability of water supply systems

An independent samples t-test was done on technical, financial, institutional and social factors to establish how livestock watering influences sustainability. The test was performed on variables whose data was available during time of the study and the results are presented in Table 6.7.

Table 6.7: Independent samples t-test results for water points used for watering livestock

	Water points used for watering livestock	Water points used for domestic purposes only	*t*-value	p-value
Factors				
Financial (%)	61.22	46.89	3.166	0.001
Technical (%)	60.92	51.10	2.192	0.015
Social (%)	64.37	49.20	3.760	0.000
Institutional (%)	69.66	51.77	1.697	0.003
Variables investigated				
Number of community water management meetings/year	7.37	4.69	3.124	0.001
Number of WPC meetings/year	6.74	2.69	3.613	0.000
Number of households attending meetings / session	24.63	16.79	3.099	0.008
Number of households making financial contributions / year	17.67	14.26	2.000	0.041
Number of vulnerable households participating in O&M / year	2.78	2.61	0.426	0.671
Amount in O&M fund	4.41	3.12	1.728	0.090
Maintenance frequency/year	4.89	2.19	5.655	0.000
Frequency of water use conflicts/month	2.26	1.95	1.168	0.248
Frequency of breakdowns / year	2.93	2.75	1.559	0.579

Influence of livestock watering on financial factors

The average financial score of water points used for livestock watering was 61.22% while that of water points used for domestic purposes only was 46.89%. The independent samples t-test results (t= 3.166, p= 0.001) show a significant difference in the average financial scores between the two groups hence the rejection of the null hypothesis on the factor. The difference in the financial variable on number of households making financial contributions per year was also statistically significant between the two groups (t= 2.000, p= 0.041). However, results showed no statistical difference between the two groups on the variable amount of O&M fund (t=1.168, p=0.090). Unlike garden farmers, livestock farmers (94%) indicated that they do not sell their livestock often hence the little amount ($4.41) in their O&M funds. The frequency of making financial contributions per year between the two groups was not statistically significant (t= -1.792, p= 0.073). However, further analysis showed a significant statistical difference for the same variable between the two groups in Gwanda District (t= 2.183, p= 0.002). This could be explained by the importance of livestock farming in Gwanda District. KII results from 61% of the respondents also highlighted that the existence of alternative water sources for livestock drinking in Chivi and Nyanga districts was contributing to the infrequency of making financial contributions towards O&M of water points used for livestock drinking in the two districts.

For the variable presence of O&M fund and presence of rules on financial collection, results for the three districts showed no significant differences between water points used for livestock watering and those used for domestic purposes only. The independent samples t-test results ($t=5.923$, $p=0.482$) showed that there is no significant difference in the presence O&M fund and the results ($t=4.089$, $p=0.097$) also showed no significant difference in the presence of rules on financial collection. However, results from Gwanda District on the same variables showed significant statistical differences between the two groups. These results show that livestock watering as a productive use of water had a positive influence on sustainability in Gwanda district since livestock rearing is an important economic activity and a source of livelihood.

Influence of livestock watering on technical factors

The average score of the technical factor for the water points used for livestock watering was 60.92% while for those used for domestic purposes only was 51.10%. The independent samples t-test results ($t= 2.192$, $p=0.015$) show a significant difference in the average technical scores between the two groups. With this result the hypothesis that the average technical scores for water points used for livestock watering and those used for domestic purposes only is the same is rejected. For the variable frequency of water point breakdowns per year, the water points used for livestock watering had a slightly higher (3.93) frequency as compared to 3.75 times for water points used for domestic purposes only. The independent samples t-test results ($t= 1.559$, $p= 0.579$) show that the difference in the breakdown frequency in the two groups is not statistically different. This could be due to the presence of alternative water sources for livestock drinking in Chivi and Nyanga districts. During field observations it was noted that, water troughs collect water which is lost when collecting water for domestic purposes, hence farmers sometimes do not pump water for their livestock. Farmers reported that in almost 50% of the cases, they water livestock with water that will be in the water troughs. Such a practice reduces physical pressure on pumps.

The average downtime of water points used for livestock drinking was 2 weeks while for those used for domestic purposes only was 2 months. The independent samples t-test results ($t= -5.369$, $p= 0.001$) show that the differences in the average downtimes between the two groups are statistically significant. However, this only applied to water points in Gwanda District as results for Chivi and Nyanga districts showed no significant differences for the same variable ($t= 3.871$, $p= 0.291$). The same pattern was also established for the variable functionality of water points as independent samples t-test results ($t=7.502$, $p=0.693$) showed no significant difference in the functionality of water points between the two groups in Chivi and Nyanga districts, while Gwanda District had results which showed a significant difference ($t= 6.037$, $p= 0.004$). These results show that in different localities, livestock watering has different impacts on the technical variables.

Influence of livestock watering on social factors

The average social score for water points used for livestock watering was 64.37% while for those used for domestic purposes only was 49.20%. As shown in Table 6.7, independent samples t-test results ($t= 3.760$, $p= 0.000$) show a significant difference between the two groups indicating that livestock watering has an influence on the social factor. With this result the null hypothesis on the factor is rejected. The variable number of households attending water management meetings had an average of 24 for the water points used for livestock drinking while it was 17 for water points used for domestic purposes only. Statistically the difference was found to be significant ($t= 3.099$, $p= 0.08$). Like technical factors discussed earlier, this result only applies to Gwanda District as the independent samples t-test results for Chivi and Nyanga districts showed no significant difference for the same variable ($t= 3.801$, $p= 0.155$). The number of vulnerable households participating in O&M of water points in the experimental group was 2.78 while that of the control group was 2.61. Independent samples t-test results ($t=0.426$, $p=0.671$) show no significant difference in the average number of vulnerable households participating in O&M of water points between the two groups thus accepting the null hypothesis for the factor. Unlike community gardening, most (58%) of the studied vulnerable households did not own livestock hence their limited participation in the management of water points used for livestock watering.

Results showed that the average number of water use conflicts for water points used for livestock drinking was 2.26 per month compared to 1.95 for water points used for domestic purposes only during the same period. The t-test results ($t= 1.168$, $p= 0.248$) show no significant difference in the average number of conflicts between the two groups. According to 66% of the key informants, this was mainly because community gardens were only accommodating a limited number of households (30%) which resulted in conflicts between garden farmers and non-garden farmers. On the other hand, almost 82% of the households benefited from livestock watering hence the low incidence of conflicts.

Influence of livestock watering on institutional factors

The average institutional score for water points used for watering livestock was 69.66% while that for water points used for domestic purposes only was 51.77%. The independent samples t-test results ($t= 1.697$, $p= 0.003$) show that there is a significant difference in the average institutional scores between the two groups. However, it was noted that the presence of WPCs between the two groups did not differ ($t = 2.441$, $p= 0.179$). WPCs were found to be present at almost 68% of the water points studied across the two groups. Despite the existence of the committees, only 40% of them were functioning at water points used for domestic purposes only while 73% were functioning at water points used for livestock watering. The chi square test results on the functionality of WPCs ($\chi^2=6.39$, $p<0.01$) show that there is a significant difference in the functionality of the committees between the two groups. According to FGD results from 84% of the sessions, WPCs at water points used for livestock drinking were considered to be critical for the maintenance and management of water points. The economic value of livestock resulted in communities setting up and supporting the WPCs.

WPCs at water points used for livestock watering conduct 6.74 water management meetings per year while those used for domestic purposes only conduct 2.69 during the same period. The independent samples t-test results ($t=3.613$, $p = 0.000$) show that there is a significant difference in the average number of WPC meetings held between the two groups. FGD results showed that WPCs at water points used for livestock watering took advantage of the meetings to clean water troughs and fence their water sources. Key informants (38%) highlighted that cleaning the water troughs was done to avoid contamination of the water sources.

6.7 Discussion

This chapter sought to explore how multiple uses of water influence sustainability of water supply systems. The multiple uses of water which were studied are domestic uses, community gardening and livestock watering. To answer the research question of the chapter on how multiple uses of water influence sustainability, a comparative analysis was done on how water points used for domestic uses only and those used for productive uses differ in sustainability. Sustainability analysis was done based on economic, social, technical and institutional factors and variables discussed in Section 6.2. Study results showed that despite the general norm of sharing water for domestic uses among villages or communities, water for productive uses was only utilized by households in a village where a water point is sited. These results are consistent with findings by Derman et al. (2005) and Mabiza (2013), where access to water for domestic consumption was not denied anyone due to social and cultural frameworks. Denying "outsiders" access to water for productive purposes could be due to land ownership practices in rural Zimbabwe. Since gardens were implemented on communal land belonging to a particular village, households not from that village were automatically excluded from benefiting from the garden projects. This implies that when implementing water points for multiple uses, central sites which can be accessed by a number of villages have to be considered.

Another key finding of the study was the unbalanced participation of men and women in community gardening. The results concur with findings by Pena (2005), Musvongo et al. (2012) and Lovewell (2014) where women participants were 60% of garden farmers. The inclusion of women in community gardening projects has a potential to economically capacitate them as the majority were unemployed. Fielmua & Mwingyine, (2015) showed that in Ghana, women were targeted in garden projects because they are the housekeepers. According to their findings when women sell vegetables their proceeds reached home and benefited the entire house, while some men were drinking alcohol. These findings show the importance of women participation in community gardening where the economic gains of the gardening activities are expected to contribute to the management of water points. Women were found to be having twofold interests in the water points, hence their commitment to make financial contributions. Despite the productive uses, the same water points were also used for domestic purposes. With the results showing that women are the primary water collectors for domestic uses at household level (Table 6.2), maintaining the water points through financial contributions is of great benefit to them. It is therefore imperative that although men may participate in community gardening activities, the gender dynamics surrounding the commitment to water point management and maintenance where multiple uses of water is practiced have to be considered.

With respect to the influence of multiple uses of water on sustainability, it was found that there was a distinct difference between the performance of water points used for multiple uses and those used for domestic purposes only (Figure 6.3). The sustainability factors which were influenced by multiple uses of water are institutional, technical, social and financial. However, the results showed that although the difference in sustainability factors between water points used for domestic purposes only and water points used for community gardens was statistically significant across the districts, this was not the same with water points used for livestock watering.

The independent samples t-test showed that water points used for community gardening were performing better than those used for domestic purposes only in all the financial variables with a statistically significant difference (Table 6.5). However, these results differ from those by Smits et al. (2010b) in their study in Honduras where water points which were used for multiple uses were not sustainable due to poor financial performance. The improved financial performance of water points in the current study could be due to the presence of rules on making financial contributions which were found at all the water points used for community gardening. Unlike community gardening, livestock watering did not have an influence on some financial factors of sustainability. This was attributed to the fact that livestock farmers do not sell their produce often like garden farmers. Garden farmers, by focusing on high value crops (Table 6.4) and producing an average of three crops in a year, were able to set up O&M funds. Although gardening may provide small amounts of income per given time, it was noted that the income was considered to be steady as it was coming on a weekly or monthly basis, enabling households to make monthly financial contributions unlike the livestock farmers. In this regard, gardens can be considered to be dependable socio-economic safety nets for household food security and financial requirements where water points are used for multiple uses (Chirinda et al. 1999). Fielmua & Mwingyine (2015) also noted that where domestic water points were used for community gardening, poor communities had the capacity to make financial contributions for O&M in Ghana. Van Koppen et al. (2006) also noted that using domestic water sources for gardening improves the willingness to pay for the O&M costs of water supply systems, showing how financial factors are influenced by multiple uses of water.

Water points used for livestock watering were performing better than those used for domestic purposes only in Gwanda District than in Chivi and Nyanga districts (Section 6.6.3). This could be due to the economic value associated with livestock rearing in Gwanda District, which makes communities prioritize the maintenance of water points used for livestock drinking. This result implies that, when implementing water sources for multiple uses considerations should be given to the livelihood activities which are of importance to the local communities for the water points to be sustained.

Gardens were influencing the increased participation of men in water management meetings. This is in line with findings by Hoko et al. (2009) where men's participation in water management was higher in cases where water was used for productive activities than where it was used for domestic purposes. This result could be due to the fact that productive water uses increase the value of water which in turn facilitates cooperation (positive engagement) among water users (Mabiza 2013).

Water points used for multiple uses had an average downtime of one week while that for those used for domestic purposes only was two months. This result was partially due to the presence of O&M funds at most water points used for multiple uses. Livestock farmers in Gwanda District and garden farmers across the three districts were giving water point breakdowns urgent attention because long down times affected their garden crops and livestock. Absence of alternative water sources forced the farmers to give breakdowns immediate attention.

On the other hand, where water points were used for domestic purposes only, households were using alternative water sources hence the prolonged downtime. Some households were using unprotected water sources in their proximity as alternative sources despite the associated health risks. These results resonate with findings by Demberere et al. (2014), where households were reported to be relying on unprotected shallow wells when their protected water sources were not functioning. Availability of alternative water points also contributed to long downtimes in Mt Darwin District of Zimbabwe (Hoko et al. 2009). This suggests that the short downtimes for the water points used for gardening and livestock watering are also due to the socio-economic benefits that the communities derive from such activities. With the current harsh economic climate in Zimbabwe, obtaining food and income for survival are central to household activities. The situation is worse in rural areas under study as households were living far below the poverty datum line (Section 6.4.1). Thus when communities find themselves rooted in deep poverty, their actions are maximized on livelihood activities, in this case, gardening and livestock rearing. This has resulted in the water sources that are used for livelihood activities being better managed than those which are only used for domestic purposes.

More vulnerable households were found to be participating in O&M where water points were used for gardening as they were targeted in the selection of garden farmers. This shows that community gardens created space for the inclusion of the poor and vulnerable households in the management of water resources. Special needs of vulnerable people have to be considered in water supply developments as sustainable water systems should be accessed and utilized by all community members (Harvey and Reed, 2006). Water facilities are found to be sustainable when the poor people who are to benefit from the facilities are provided with sustainable livelihoods (Nicol 2000). Therefore accessing productive use activities, in this case gardening and livestock watering, is one way that can be scaled up in rural communities of Zimbabwe to address the barriers that hinder the participation of vulnerable and poor households in water management. Such projects should be coupled with capacity building programmes to enable the households to develop the required skills in productive activities for maximum benefits to be achieved.

Where water points are used to water community gardens, frequencies of water use conflicts were found to be higher than where water points were used for domestic purposes only. This result concurs with results by Smits et al. (2010b) in Honduras. In their findings, they noted that sustainability of water supply systems used for productive purposes was threatened by conflicts. In their case conflicts were between large scale water users and small scale water users. Where water points will be used for multiple purposes, domestic purposes have to be prioritized during water scarce times since access to water is a basic human right. Imparting conflict management skills in the communities may also be a solution to sustainability challenges caused by conflicts. This is because conflicts in water use if not well managed have adverse impacts on the sustainability of water points as they may result in the vandalism of the infrastructure (Van Koppen et al. 2006; Smits et al. 2010a).

6.8 Summary

Using the independent samples t-test and the paired samples t-test, it was concluded that generally water points used for community gardening and livestock watering positively influence sustainability. These tests were done on institutional, technical, social and financial factors. However, it was also discovered that using drinking water sources for multiple uses increases the frequency of water use conflicts and water point breakdowns which negatively impact on sustainability. This means that where water sources will be used for multiple uses additional management skills and resources may be required for the water points to be sustained. Results presented in the chapter also showed that livestock watering did not have an influence on sustainability for water points in Nyanga and Chivi districts but it was observed to be influencing sustainability in Gwanda District. This shows that where multiple uses of water is practised the livelihoods activities that should be supported should be of economic value to the communities for the water supply systems to be maintained.

7 CONCLUSIONS

7.1 Introduction

This chapter is a synthesis of the key findings of the study. The main aim of the study was to explore the factors and the CBM implementation practices influencing sustainability of water supply systems in Zimbabwe, and how they can be incorporated during different stages of development of a water supply project. Specifically, the study determined the factors influencing sustainability of water supply systems in Zimbabwe. The study also investigated how the implementation of CBM is contributing to the sustainability of water supply systems, with an emphasis on how the practices of different stakeholders in the water sector differ from their prescribed roles according to the CBM framework. The other specific objective of the study was to explore how multiple uses of water such as community gardening and livestock watering, influence the sustainability of water supply systems. Finally, a sustainability framework for the rural water supply sector of Zimbabwe was developed.

7.2 Factors influencing sustainability of water supply systems

The findings of this study show that sustainability of water supply systems is a challenge in rural areas of Zimbabwe, with an average of 33% unsustainable water points. The sustainability levels varied from one district to another. The technical factors which influenced sustainability are type of water lifting device, availability and affordability of spare parts, functionality of water points and pump status. The type of water lifting device used significantly influences sustainability as the ANOVA results showed a significant difference in the mean sustainability scores for each lifting device. Different lifting devices also varied significantly in the average downtime and functionality. The rower pump had the shortest average down time of two weeks while other lifting devices had 2 months. Differences in functionality and average down time across water lifting devices were attributed to the availability of spare parts at community level and the cost of making repairs. Lifting devices which are considered easy to use by the young, old, disabled and pregnant women are preferred and well maintained more than the difficult ones. Although the type of water lifting device is not the single influence of sustainability, it is an important explanatory variable.

Sustainability is also influenced by the institutional factors such as existence of user committees, functionality of user committees, the level of external support and training in CBM. User committees which were present are the WPCs and maintenance committees. While both committees are crucial for sustainability to be achieved, findings of this study show that the WPCs are the most critical. WPCs were also the most common in the study area as they were found at 95% of the studied water points. However, the existence of these committees did not guarantee their functionality. Water points that had functional WPCs were sustainable with an average sustainability score of 67.4% while those without the committees had an average sustainability score of 29.8% which is in the partially sustainable category. CBM training is critical for user committees to effectively perform their expected roles. User committees which were not trained in CBM had poor managerial, technical and financial management skills which contributed to unsustainable water points. Despite the importance of CBM training as evidenced by this study's findings, and as has been highlighted in much literature on sustainability, the responsible authorities were not adequately providing the training, since only 46% of the WPCs were trained in CBM.

The social factors which had an influence on sustainability are conflict management, community participation in planning, and O&M. Community participation during the planning stage was passive and it had negative impacts on technical factors. The participation of communities during the O&M stage is critical for sustainability; however, external support from institutions at national and district levels are indispensable since communities are not able to fund and carry out all major breakdowns on their own. The high (71%) prevalence of water use conflicts had negative impacts on sustainability where the conflicts were not properly managed. This shows the need and importance of conflict management skills within communities.

The financial factors which influenced sustainability are presence of O&M fund, regularity of making financial contributions, adequacy of O&M funds and availability of rules on fee collection. Water points that had an O&M fund were in the sustainable and highly sustainable categories. The absence of the fund at most water points was due to irregularity of making financial contributions, mismanagement of funds and poverty. With the harsh economic situation prevailing in Zimbabwe, paying for O&M for water systems was not prioritized, as communities preferred to make financial contributions after a break down when they would be seeing the need and urgency to pay. In turn, this prolonged the downtime. While it is undeniable that the communities had low incomes, the absence of the O&M funds was also as a result of lack of transparency in management of the funds and absence of rules on O&M fees collection.

The environmental factors which had an influence on sustainability are water quality at source and reliability of water supply. Communities complained of boreholes which supplied water with a salty taste. Such boreholes were sometimes neglected and not maintained in the presence of alternative water sources which were perceived to provide water of a better taste. In terms of reliability, water points which did not supply water throughout the year were not maintained during the dry season resulting in some of the water points being vandalized. Intermittent supply by some water points caused pressure on perennial water sources resulting in frequent breakdowns.

7.3 CBM implementation

The results on CBM implementation show that the challenge in Zimbabwe is not lack of a guidance/ framework that supports the implementation of the approach, but lack of support for the implementation of the frameworks' provisions. With regard to the institutions at district level, the DWSSC is weak in coordinating the sector due to lack of financial resources within the government departments. The sector has not been receiving government funding since 2011, which is a threat to the guidelines intended to enhance the implementation of CBM. This is despite the guidelines being technically well designed. The limited financial resources have incapacitated the government institutions to fully perform their duties; as a result these institutions are detached from the communities they serve. Sector ministries focus on their key duties leading to fragmented efforts which negatively affect the implementation of CBM.

The RDCs have developed a culture of heavy reliance on donor funding for the development of water supply infrastructure. The RDCs were not allocating the stipulated 15% of their annual budgets towards water development. All the RDCs did not have revolving funds to assist communities in water management and development as prescribed by the CBM framework. The little amounts that they were allocating towards water development were never released towards water activities. The challenge with donor funds is that they are mainly directed towards the installation and repair of infrastructure and they are only available within a stipulated period. Absence and or limited funding for setting up community level structures and carrying out training which is stipulated in the CBM framework has adversely affected sustainability. Although the RDCs are well positioned to involve rural communities in development projects, their financial performance questions their capacity as authorities of water supply and sanitation in rural areas. Their designation in the rural water sector therefore challenges them to increase their financial capacity for sustainability to be achieved through CBM implementation.

NGOs are key institutions in the water sector and they are the most resourced at district level. However, some of their projects were implemented in a rushed manner resulting in the omission of some of the CBM steps. In turn, community structures responsible for water management were not formed in some cases, and where they were formed, some of them were not adequately trained. Rushed project implementation also contributed to inadequate community participation during planning for water projects resulting in inappropriate technology selection. Effective monitoring on how CBM is implemented could be a solution to such challenges.

A distinction on what is prescribed by the CBM framework and what is being implemented was also found at the community level. The mismatch between theory and practice in CBM implementation at local level was emanating from practices by the institutions at the national and district levels. Lack of financial resources at district level influenced the level and frequency of technical and managerial training offered to community institutions. This adversely affected the implementation of CBM as the communities who are expected to operate and maintain water supply systems did not have the adequate and relevant skills to do so. Political influence was also impacting negatively on CBM implementation. The influence of politics on the development of plans at local level, questions the legitimacy of development plans used in the water sector. This shows that despite the government's legal commitments to decentralization, in practice power continues to reside in higher administrative units and individuals.

7.4 Multiple uses of water

The multiple uses of water which were studied are domestic uses, community gardening and livestock watering. A difference in performance in sustainability was observed between water points used for domestic uses only and those used for multiple uses. The sustainability factors which were influenced by multiple uses are the institutional, technical, social and financial. The difference in sustainability performance between water points used for domestic purposes only and those used for community gardening was statically significant across the districts, this was not the same with water points used for livestock watering. Water points used for livestock watering had a significant difference in sustainability performance with those used for domestic purposes in Gwanda District only. This was attributed to the relative importance of livestock farming in the Matabeleland region where Gwanda District is located. Partly, this was also due to the presence of alternative water sources for livestock watering in Chivi and Nyanga districts.

The impact of gardening on financial factors was on the frequency of making financial contributions, presence of an O&M fund, amount of the O&M fund, rules on fee collection, and the number of households making financial contributions. A significant difference was shown in the financial performance between water points used for domestic purposes only and those used for community gardening. Garden farmers made frequent financial contributions using money they earned through selling garden produce. Gardens, being a source of livelihood and income, improved the willingness to pay of communities, hence the increased number of households who were making financial contributions. Improved financial performance of water points used for community gardening resulted in short downtimes. Unlike community gardening, livestock watering did not have an influence on some financial factors. No statistical differences were shown between water points used for livestock watering and those used for domestic purposes on the amount of O&M fund, presence of rules on fee collection and frequency of making financial contributions. This was partly attributed to the fact that livestock farmers do not sell their produce often like garden farmers do.

Multiple uses of water had an influence on institutional factors such as existence and functionality of WPCs, frequency of WPCs meetings, frequency of community management meetings, and the number of households attending water management meetings. Water management meetings were held more frequently at water points used for multiple uses especially where gardening was being practised, as the water users maximized on the time they were doing their garden activities. This also resulted in higher attendance being recorded as compared to where multiple uses of water were not practised. Gardens also had a positive influence on the attendance of men at water management meetings due to the associated economic value.

Technical factors which were influenced by multiple uses of water are average down time, frequency of breakdowns and frequency of maintenance. Water points which were used for multiple uses had an average downtime of one week while those used for domestic purposes only had an average of two months. The short downtime for water points used for multiple uses was partly due to absence of alternative water sources. Community gardens created space for inclusion of the poor and vulnerable households in the management of water resources. The participation of the poor and vulnerable households is important since their views and special needs have to be considered in water supply development and management. However, community gardening increased the frequency of water points breakdowns due to pressure of use. Multiple uses of water also increased the frequencies of water use conflicts which were prevalent during time when water was scarce.

7.5 Framework for the rural water supply systems in Zimbabwe

Based on the findings of this study, a framework for the rural water supply systems in Zimbabwe, and other similar contexts was developed (Figure 7.1). The framework shows how the principal factors of sustainability, and the best CBM implementation practices, can be incorporated in water supply project stages to improve sustainability.

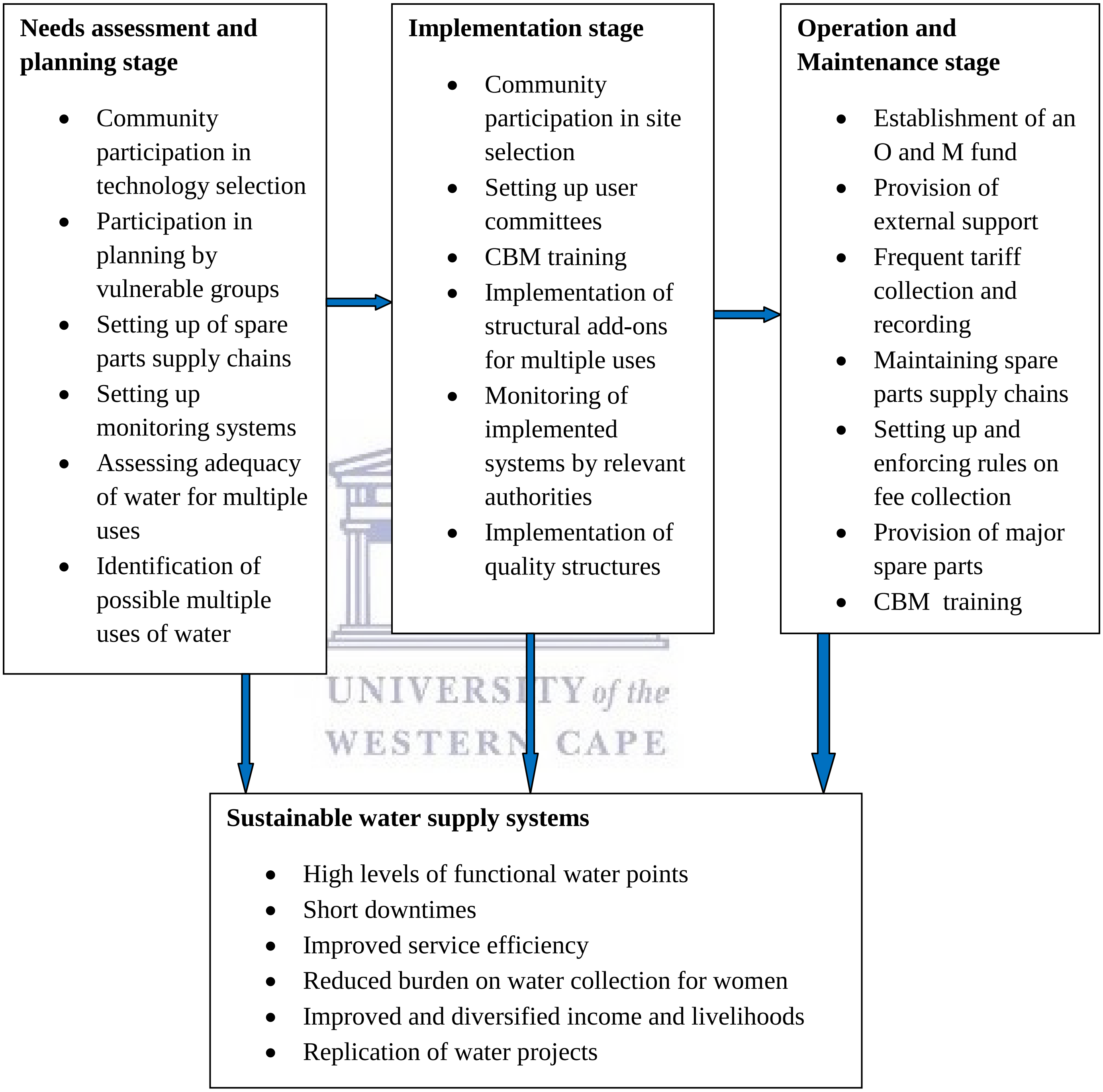

Figure 7.1: Framework for the rural water sector in Zimbabwe.

Needs assessment and planning stage

During the needs assessment and planning stage, there is need to engage communities in the selection of the type of technology they are able to operate and maintain. Given the wide range of technologies available in the rural water sector, the selection of technology by user communities has been associated with sustainability (U-Dominic 2014). Generally, rural communities with low and unstable monthly incomes prefer low cost technologies which can be repaired easily by local people. Technologies which can be used by children, the elderly, pregnant women and the physically-challenged are also preferred to those which are considered to be difficult to use. After technology selection, spare parts supply chains have to be set up to promote the availability of spare parts close to communities. Monitoring systems in the sector also need to be established such that projects are implemented as prescribed.

Multiple uses of water have to be planned for during the needs assessment and planning stage of a water supply project. Firstly, assessments on water adequacy have to be carried out to enable appropriate decisions to be made so that communities are not prevented from accessing water for domestic uses which is the primary use. Secondly, there is need to identify the appropriate productive uses which are of importance to the communities for sustainability to be improved. Literature and discussions in Chapter six indicate that, the relative importance of the productive uses are critical for communities to be motivated to maintain the water points (Van Koppen et al. 2006; Smiths et al. 2010).

Implementation stage

During the implementation stage, participation by all relevant institutions in the water sector is critical. The government institutions should offer technical assistance to the implementing organizations. They should also monitor how different stakeholders implement water supply projects as this assists in establishing if CBM is implemented according to the prescribed guidelines. The participation of local institutions such as VIDCOs, WADCOs, and traditional leaders is also critical during the planning stage. Participation of these institutions can be through mobilizing communities to provide labour as well as locally available materials. The local institutions should also participate in site selection. Community participation in site selection through the local institutions or leaders can avoid potential conflicts that may arise when water points are wrongly sited.

Setting up user committees during the project implementation stage is vital for sustainability to be achieved. These committees should include the WPCs and the maintenance committees. Literature has shown that, these management structures are responsible for the daily management of water points hence their importance for sustainability (Bakalian & Wakeman, 2009; Smith et al. 2011; Quin et al. 2011). Results discussed in Chapters Four and Five showed that, water points that had functioning water user committees had higher sustainability scores as compared to those which did not have the committees. However, these committees have to be trained in CBM for them to be effective. The training should aim to build managerial, technical, conflict management, as well as financial management capacity.

At the implementation stage there is need to implement structural add-ons to support multiple uses of water. The add-ons can be installation of storage facilities as well as augmenting diameters of pipes if the water point is used for gardening. Where the water point is used for livestock drinking, there is need to construct livestock drinking troughs so as to maintain the drinking water quality (Makoni & Smits 2007). As argued by Van Koppen et al. (2006), these add-ons are important for sustainability to be achieved.

Operation and maintenance stage

Establishment of an O&M fund is of importance for sustainability to be achieved. As discussed in Chapters Four and Five, water points that had an O&M fund had short downtimes and higher sustainability scores than those which did not have the fund. However, there is need to set up and enforce rules on fee collection so that all households will be obligated to make the financial contributions towards the fund. Institutionalising transparency in the use and management of O&M funds also increases the frequency of making financial contributions. This could be done through adequate training on financial management and record keeping as well as reporting on financial expenditures to the communities.

The provision of external support by institutions at national and district levels through monitoring of water points performance, provision of major spare parts and technical assistance during major breakdowns is crucial for sustainability. As elaborated in Chapter Four, water points which were receiving external support were more sustainable than those which were not receiving the support. Spare parts supply chains established during the needs assessment and planning stage should be maintained at the O&M stage. This can be done by creating enabling environments that attract the participation of the private sector in the supply of spare parts. Alternatively, government departments as service providers can institutionalize the supply chains where profit margins fail to attract the participation of the private sector.

CBM training during the O&M stage is important for sustainability to be improved. As elaborated in Chapters Four and Five these courses motivate the WPC members to perform their duties. The training is also a platform to train new members who replace those who may have migrated, passed on, or stepped down from the committees. In poor rural settings, where making frequent financial contributions is a challenge, using water points for multiple uses may financially capacitate communities and increase their willingness to make frequent financial contributions.

Sustainable water supply systems

Incorporating sustainability factors and best practices in CBM into the project stages as illustrated in Figure 7.1, contributes to high levels of functional water points and improved service efficiency. In turn, high numbers of functional water points improve water access for both domestic and productive purposes. The other outcomes will be reduced downtimes and reduced burden on water collection for women. As discussed in Chapter Four, long down times increase the burden on water collection for women as they travel long distances to alternative water sources. In some cases the alternative water sources are unprotected, threatening human health. Multiple uses of water may be promoted where water will be adequate, and this improves and diversifies income and livelihoods for rural communities. The overall outcome of this will be sustainable water projects which may be replicated in other areas.

7.6 Summary

The sustainability of water supply systems is a major challenge in rural Zimbabwe, as evidenced by high levels of unsustainable water points presented in this study. Sustainability is influenced by institutional, technical, social, environmental and financial factors. The technical factors which influenced sustainability are availability and affordability of spare parts, functionality, average down time and ease of use. The presence and functionality of water user committees, training in CBM and the level of external support were the institutional factors which impacted on sustainability. Training in CBM had an impact on technical, institutional and financial factors, showing the interconnections of the sustainability factors. The economic factors which influenced sustainability are presence of an O&M fund, regularity of making financial contributions, adequacy of funds and rules on fee collection. Economic factors were among the principal factors of sustainability, such that water points which had a poor performance on the factors were also not sustainable. Sustainability was also influenced by institutional factors such as conflict management, community participation in planning and, in O&M. The environmental factors of water quality at source and reliability of water supply also had an impact on the sustainability of water supply systems.

The implementation of the CBM approach was not according to the guidelines outlined in the CBM framework. Poor coordination within the district institutions negatively impacted on the implementation of CBM. The institutions were financially under resourced resulting in some of the requirements of CBM not being implemented. The challenges at the district level also influenced the way CBM was implemented at the community level. As a result, the institutions at the community level lacked adequate skills in carrying out O&M of the water systems. Limited external support that the local institutions and the communities were receiving also had an impact on sustainability. The divergence of CBM implementation from the prescribed guidelines, by different stakeholders contributed to unsustainable water points.

Multiple uses of water had an impact on social, institutional, technical and financial factors. The influence of multiple uses of water on sustainability depends on the type of productive uses being practised and their relative importance to the communities. Productive purposes such as gardening which bring income on daily, weekly and monthly basis resulted in frequent contributions on O&M being done as compared to livestock rearing that do not bring income often. Although the practice generally had a positive influence on sustainability, it increased the frequency of water use conflicts and water points breakdowns.

The framework for the rural water sector in Zimbabwe discussed in Section 7.5 shows that, although the sustainability factors are known, they need to be addressed at different stages of a water supply project. Sustainability being a challenge mainly in resource constrained countries, priority may be given to the principal factors. The CBM best implementation practices also need to be incorporated into the project stages. The government (central and local) has to influence the development and implementation of legal and policy frameworks that support CBM. The government institutions and other stakeholders should be adequately resourced in order to effectively perform their expected roles. At the local level, communities have to be empowered with the adequate skills, knowledge, as well as livelihood activities that support the maintenance of water points.

7.7 Areas for further research

The findings of this study mainly focus on how sustainability is influenced by different factors, the implementation of the CBM approach, and multiple uses of water. Based on the findings, further research can be on the interrelatedness of key factors of sustainability. Establishing such connections assists in identifying the root cause of unsustainable water systems. The possibility of professionalising CBM by engaging the private sector in the rural water sector is also another potential area of further research. The research may focus on how the private sector may be attracted to participate in the sector through maintenance of water points and provision of spare parts. Further research may also focus on how other productive uses of water such as brick moulding impact on the sustainability of water supply systems. Methodologically, future research may use longitudinal studies to investigate how sustainability factors change over time, and how the changes influence the sustainability of water supply systems. Future studies may also investigate factors that influence sustainability of self-supplied and managed systems, as well as piped water systems which are commonly used in growth points of Zimbabwe.

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9 APPENDICES

Appendix 3.1 : Water Point Committee Questionnaire

District ………..	Ward ………..	Village ……….	Water Point No ……….	Enumerator ……….….

Introduction and purpose of the interview:

Good morning/afternoon. My name is Mrs Tendai Kativhu I am conducting a survey on water supply services in this area. The purpose of the survey is to assess sustainability of water supply systems in your ward. The data which will be collected through the survey will be used to advise the government of Zimbabwe and other relevant organisations to improve sustainability of water supply in your area. Your water point has been selected to participate in this study.

Confidentiality and Consent: This survey will not collect information that can be used to identify you as an individual or WPC. You are free to participate or to choose not to participate in this survey. If at any time during the interview you feel you no-longer want to continue with the interview please inform the interviewer who will stop the interview at that moment. Your answers to the questions that you will be asked will not be revealed to anyone except the research team. You are free not to answer questions that you are not comfortable answering. You will not be contacted by any one concerning the answers you give. The interview will take approximately 45 minutes.

To show your consent please sign in the space below.

I certify that the purpose of this research has been explained to me.

Signature:...

Position in WPC:.......................................

Date: ....

Demographic information

Q1.1 Names of respondents	1.2 Sex	1.3 Age	1.4 Position in WPC	1.5 Level of education	1.6 Number of years as a WPC member

Water point information

Q2.1 When was the water point constructed?	
Q2.2 Who constructed the water point?	
Q2.3 How many households use the water point?	
Q2.4 How many villages use the water point?	
Q2.5 What is the distance that the furthest household walk to the water point?	

Water systems sustainability	
Technical and environmental factors	
Q3.1 Does the water point, supply water all year round?	1. Yes 2. No
Q3.2 If **No,** please explain which months the water point supplies water.	
Q3.3 Does the water point supply water throughout the day?	1. Yes 2. No
Q3.4 If **No,** please explain what time of the day the water point supplies water.	
Q3.5 Do people queue to fetch water?	1. Yes 2. No
Q3.6 If **yes** which times of the day do people normally queue?	
Q3.7 Is the water point currently working?	1. Yes 2. No
Q3.8 If **No,** for how long has it not been working?	1. Hours 2. Days

	3. Weeks 4. Months
Q3.9 How long does it take before the water point is repaired?	1. Hours 2. Days 3. Weeks 4. Months
Q3.10 What is the frequency of breakdowns /year	
Q3.11 What is the maintenance frequency /year?	
Q3.12 Where do you get spare parts for the lifting device fitted on your water source?	
Q3.13 In your own opinion are the spare parts affordable?	
Q3.14 Water comes after how many strokes (in the case of boreholes)?	
Q3.15 Is the lifting device easy or difficulty to use?	
Q3.16 Give reasons for your answer in Q3.15	
Q3.17 When the water point is broken down what other sources of water do households use?	1. Nearest borehole 2. Protected well 3. Unprotected well 4. Spring 5. Dam 6. River 7. Others (specify)....................
Q3.18 What is your perception on the taste of the water?	1. Excellent 2. Good 3. Bad
Q3.19 What is your perception on the smell of the water?	1. Excellent 2. Good 3. Bad
Q3.20 What is your perception on the colour of the water?	1. Excellent 2. Good 3. Bad
Social factors	
Q4.1 How were the users informed about the project when the water point was constructed?	1. Village meetings 2. Individual consultation 3. Saw project being implemented 4. Others (specify)......................
Q4.2 Did households participate during the needs assessment stage?	1. Yes 2. No
Q4.3 Who made the choice of the technology?	1. Community 2. Women 3. Men

	4. Community leaders 5. Local government 6. Do not Know 7. Others (specify).................
Q4.4 Are you happy with the technology?	1. Yes 2. No
Q4.5 If **No** may you indicate why?	Answer..........................
Q4.6 Who made choice of location of the water point?	1. Community 2. Women 3. Community leaders 4. Local government 5. Do not know 6. Others (specify)...................
Q4.7 How are the water point committees selected?	1. Voting by community 2. Imposed by leaders 3. Volunteer 4. Do not know 5. Others (specify)....................
Q4.8 As the WPC, how do you participate in the operation and maintenance of the water point?	
Q4.9 In your own opinion is the participation adequate?	1. Yes 2. No
Q4.10 May you support your answer in Q4.9.	
Q4.11 Do the poor, disabled and elderly participate in water supply projects	1. Yes 2. No
Q4.12 Are the groups identified in Q4.11 well represented in WPC?	1. Yes 2. No
Q4.13 How many vulnerable households participate in O and M?	
Q4.14 Do you think the representation of women is good for the project? Why and why not?	
Q4.15 What kind of conflicts normally arise concerning the water point? (Rank starting with the most frequent)	1. 2. 3. 4. 5.

Q4.16 How are these conflicts normally resolved?	Answer..................
Q4.17 Who mediates during conflicts?	1. Chief 2. Village head 3. Councillor 4. WPC 5. Others (specify)........................
Financial factors	
Q5.1Does the water point has an operation and maintenance fund?	1. Yes 2. No
Q5.2 How many households make financial contributions per month?	
Q5.3 Besides cash how else do households contribute towards the maintenance of the water point?	1. Labour 2. Grain 3. Livestock 4. Others (specify).....................
Q5.4 When are the financial payments for operation and maintenance made?	1. After a breakdown 2. Weekly 3. Monthly 4. Others (specify)....................
Q 5.5 What is the amount of money in the O and M fund	
Q5.6 Who keeps the money for operations and maintenance?	1. Chairperson of WPC 2. Treasurer of WPC 3. Village head 4. Do not know 5. Others (specify)...............
Q5.7 Are the funds adequate to cover operation and maintenance costs of the water point?	1. Yes 2. No
Q5.8 Are the expenditures and incomes registered and checked by a second person?	1. Yes 2. No
Q5.9 Are there rules regarding fee collection and management?	1. Yes 2. No
Q5.10 What is done to those who break the rules?	1. Not allowed to fetch water 2. Pay a penalty 3. Nothing 4. Others (specify)...................................
Institutional Factors	
Q6.1 Is the WPC functioning?	1. Yes 2. No
Q6.2 How many members are in the WPC	Males Females

Q6.3 Which positions do the men and women hold in the WPC	1. 2. 3. 4. 5. 6. 7.
Q6.4 Was the WPC trained in CBM?	1. Yes 2. No
Q6.5 When was the training done?	
Q6.6 How long was the training?	
Q6.7 Who offered the training?	
Q6.8 In your opinion was the training adequate	1. Yes 2. No
Q6.9 Give reasons to your answer in Q 6.8	
Q6.10 Have you ever received a refresher training in CBM?	
Q6.11 How often do you hold WPC meetings per year?	
Q6.12 How many WPC members normally attend WPC meetings per session?	Males Females
Q6.13 How often do you hold community water management meetings per year?	
Q6.14 How many household members normally attend water management meetings per session?	Males Females
Q6.15 Does the water point have a maintenance committee	1. Yes 2. No
Q6.16 Is the maintenance committee functioning?	1. Yes 2. No
Q6.17 Does the maintenance committee have adequate skills to perform their duties?	1. Yes 2. No
Q6.19 Does your water point get external support from institutions at district and national level?	1. Yes 2. No
Q6.20 Which organisations offer the support?	
Q6.21 Which forms of support do you normally receive?	
Q6.22 Are you involved in the monitoring of the water point as a committee?	1. Yes 2. No
Q6.23 If yes how often do you monitor the water point?	1. Daily 2. Twice a week

	3. Weekly 4. Monthly 5.Others (specify).............................
Q6.24 To who do you report your monitoring results?	
Multiple uses of water	
Q7.1 Is the water point used for community gardening	1. Yes 2. No
Q7.2 Is the water point used for livestock watering	1. Yes 2. No
Q7.2 When was the garden established/ water trough	
Q7.3 How many farmers are in the garden/ households water their livestock from the water point?	Males Females
Q7.4 How many vulnerable households participate in gardening?	
Q7.5 How big is your garden	
Q7.6 How big is each farmer's plot?	
Q7.7 Who allocates land to the farmers?	
Q7.8 Which crops are planted in the garden?	
Q7.9 Do farmers sell their garden produce?	1. Yes 2. No
Q7.10 Where do they sell their produce?	
Q7.11 Do you receive any assistance from district or ward level officers on garden farming?	
Q7.13 Which conflicts are caused by gardening at the water point?	1. 2. 3 4.
Q7.14 When do the conflicts usually occur?	
Q7.15 May you indicate how the following factors are influenced by gardening;	

Factor	**Before**	**After**
Number of water management meetings /year		
Number of WPC meetings /year		

Number of households attending water management meetings per session		
Number of households making financial contributions per month		
Frequency of making financial contributions		
Number of vulnerable households attending water management meetings/ session		
Number of vulnerable households participating in operation and maintenance		
Number of men attending meetings		
Number of water conflicts / month		
Frequency of breakdowns /year		
Maintenance frequency per year		
Average down time		
Presence of O and M fund		
Amount in O and M fund		
Presence of rules on fee collection		

Challenges with non functional water points	
8.1 What challenges do you face when your water point is broken down?	1 2 3 4 5
8.2 How do you cope with these challenges?	1 2 3 4 5
8.3 What do you think should be done to improve sustainability of your water point	1 2 3 4

Thank you for your time

Appendix 3.2: Household Questionnaire

District	Ward	Village	H/H No	Enumerator
………..	………..	……….	……….	……….....

Introduction and purpose of the interview:

Good morning/afternoon. My name is Mrs Tendai Kativhu I am conducting a survey on water supply services in this area. The purpose of the survey is to assess sustainability of water supply services in your ward. The data which will be collected through the survey will be used to advise the government of Zimbabwe and other relevant organisations to improve sustainability of water supply services in your area. Your household has been selected to participate in this study.

Confidentiality and Consent: This survey will not collect information that can be used to identify you as an individual or household. You are free to participate or to choose not to participate in this survey. If at any time during the interview you feel you no-longer want to continue with the interview please inform the interviewer who will stop the interview at that moment. Your answers to the questions that you will be asked will not be revealed to anyone except the research team. You are free not to answer questions that you are not comfortable answering. You will not be contacted by any one concerning the answers you give. The interview will take approximately 45 minutes.

To show your consent please sign in the space below.

I certify that the purpose of this research has been explained to me.

Signature:..

Date: ....

Demographic information

Q1.1 Names of respondent	1.2 Sex	1.3 Age	1.4 Relationship to h/h head	1.5 Level of education	1.6 Number of family members	1.7 Employment

Household socio-economic status

Q2.1 What is the household's main source of income?	1. Waged formal employment 2. Business (vendor/cross border trade) 3. Occasional casual worker 4. Agriculture 5. Gardening 6. Fishing 7. Livestock/ poultry sales 8. Remittances 9. Others (specify)..
Q2.2 What is the household's monthly average income in US$?	1. 0-50 2. 51-100 3. 101-150 4. 151-200 5. Above 201
Q2.3 Which of the following does your household own?	1. Cattle 2. Goats 3. Sheep 4. Poultry 5. Wheelbarrow 6. Scotch cart
Q2.4 On average how much money do you spent per month for water facilities repairs and maintenance contributions?	US$.................

Water Supply	
Q3.1 What is the household's main source of water for domestic purposes?	1. Borehole 2. Protected well 3. Unprotected well 4. Tap water 5. Spring 6. Others (specify)............................
Q3.2 How much water do you use per day for domestic purposes?	1. Answer.............litres 2. Do not know
Q3.3 How much water do you collect per day from your main source?	Answer..............................
Q3.4 What do you use to carry water from the source in Q 3.1?	1. Head 2. Wheel barrow 3. Cart 4. Hand 5. Bicycle 6. Others (specify)..........................
Q 3.5 Who usually goes to fetch water from the main source of water for the household?	1. Adult woman (age 15+ years) 2. Adult man (age 15 + years)

	3. Female child (under 15years) 4. Male child (under 15 years)
Technical and environmental factors	
Q4.1 Is the water you get from the main source adequate for your domestic uses?	1. Yes 2. No
Q4.2 If the answer for Q4.1 is **No**, where do you get water to supplement your domestic uses?	Answer...............
Q4.3 Does your main source of water, supply water all year round?	1. Yes 2. No
Q4.4 If **No,** please explain which months do you get water from the main water source.	Answer........................
Q4.5 Does the water source supply water throughout the day?	1. Yes 2. No
Q4.6 If **No,** please explain what time of the day you get water from the main source.	Answer.......................
Q4.7 What is the estimated distance to the main water point?	
Q4.8 What is the estimated time that you take for a round trip to collect water from the water point?	......................minutes/ ....hours
Q4.9 Do you queue to fetch water?	1. Yes 2. No
Q4.10 If **yes** for how long do you normally queue?	Answer.................
Q4.11 Is the water point currently working?	3. Yes 4. No
Q4.12 If **No** for how long has it not been working?	5. Hours 6. Days 7. Weeks 8. Months
Q4.13 How long does it take before the water point is repaired?	5. Hours 6. Days 7. Weeks 8. Months
Q4.14 Where do you get spare parts for the lifting device fitted on you water source	Answer..
Q4.15 In your opinion are the spare parts affordable?	Answer...
Q4.16 Water comes after how many strokes (in the case of boreholes)?	Answer..
Q4.17 Is the lifting device easy or difficulty to use	Answer...
Q4.18 Give reasons for your answer in Q.17	Answer..
Q4.19 Are you satisfied with the reliability of the system?	1. Yes 2. No

Q4.20 When the water point is broken down what other source of water do you use?	8. Nearest borehole 9. Protected well 10. Unprotected well 11. Spring 12. Dam 13. River 14. Others (specify)....................
Q4.21 What is the estimated time that you take for a round trip to collect water from the alternative water point?	Answer ....minutes/ ....hours
Q4.22 What is your perception on the taste of the water from the main water source?	2. Excellent 2. Good 3. Bad
Q4.23 What is your perception on the smell of the water from the main water source?	2. Excellent 2. Good 3. Bad
Q4.24 What is your perception on the colour of the water from the main water source?	2. Excellent 2. Good 3. Bad
Social factors	
Q5.1 How were you informed about the project when the water point was constructed?	5. Village meetings 6. Individual consultation 7. Saw project being implemented 8. Others (specify)......................
Q5.2 Did you participate during the needs assessment stage?	3. Yes 4. No
Q5.3 Who made the choice of the technology?	8. Community 9. Women 10. Men 11. Community leaders 12. Local government 13. Do not Know 14. Others (specify).................
Q5.4 Are you happy with the technology?	3. Yes 4. No
Q5.5 If **No** may you indicate why?	Answer..........................
Q5.6 Who made choice of location of the water point?	7. Community 8. Women 9. Community leaders 10. Local government 11. Do not know 12. Others (specify)...................
Q5.7 How are the water point committees selected?	6. Voting by community 7. Imposed by leaders 8. Volunteer 9. Do not know 10. Others (specify)....................
Q5.8 How do you participate in the operation and maintenance of the water point?	Answer................................

Q5.9 In your own opinion is the participation adequate?	3. Yes 4. No
Q5.10 May you support your answer in Q4.8.	Answer................................
Q5.11 Do the poor, disabled and elderly participate in water supply projects	3. Yes 4. No
Q5.12 Are the groups identified in Q4.10 well represented in WPC?	3. Yes 4. No
Q5.13 Do you think the representation of women is good for the project? Why and why not?	Answer..........................
Q5.14 What kinds of conflicts normally arise concerning the water point? (Rank starting with the most frequent)	1. 2. 3.
Q5.15 How are these conflicts normally resolved?	Answer..................
Q5.16 Who mediates during conflicts?	6. Chief 7. Village head 8. Councillor 9. WPC 10. Others (specify)........................
Financial factors	
Q6.1Does the water point has an operation and maintenance fund?	3. Yes 4. No
Q6.2 As a household, are you making any payments towards operation and maintenance of the water point?	1. Yes 2. No
Q6.3 If **not** why?	Answer............................
Q6.4 Besides cash how do you contribute towards the maintenance of the water point?	5. Labour 6. Grain 7. Livestock 8. Others (specify).....................
Q6.5 When are the payments for operation and maintenance collected?	5. After a breakdown 6. Weekly 7. Monthly 8. Others (specify)....................
Q6.6 Who keeps the money for operations and maintenance?	6. Chairperson of WPC 7. Treasurer of WPC 8. Village head 9. Do not know 10. Others (specify)...............

Q6.7 In your own opinion are the funds adequate to cover operation and maintenance costs of the water point?	3. Yes 4. No
Q6.8 Are the expenditures and incomes registered and checked by a second person?	3. Yes 4. No
Q6.9 Do you think that the collected fee is properly managed?	1. Yes 2. No
Q6.10 Are there rules regarding fee collection and management?	3. Yes 4. No
Q6.11 What is done to those who break the rules?	5. Not allowed to fetch water 6. Pay a penalty 7. Nothing 8. Others (specify)...................................
Institutional factors	
Q7.1 Does the water point have a WPC?	1. Yes 2. No
Q7.2 Is the WPC functional?	1. Yes 2. No
Q7.3 In your own opinion does the WPC have the capacity to manage the water point?	1. Yes 2. No
Q7.4 Give reasons to your answer in Q7.3	Answer...
Monitoring	
Q8.1 Are you involved in the monitoring of the water point?	3. Yes 4. No
Q8.2 If yes how often do you monitor the water point?	1. Daily 2. Twice a week 3. Weekly 4. Monthly 5. Others specify...
Q8.3 To who do you report your monitoring results?	Answer..
Multiple uses of water	
Q9.1 Is your water point used for community gardening	3. Yes 4. No
Q9.2 Is your water point used for livestock watering	1. Yes 2. No
Q9.3 Is your household participating in the community garden.	1. Yes 2. No

Q9.4 If answer to Q9.3 is **Yes** when did your household start gardening?	Answer.....................................
Q9.5 In your household who is the registered member?	Answer...................................
Q9.6 Do you sell your surplus produce?	2. Yes 3. No
Q9.6 On average how much income do you earn per month from selling the garden produce?	Answer US$...................................
Q9.10 What do you use the income from gardening for?	Answer ....
Challenges with broken down water points	
10.1 What challenges do you face when your main water point is broken down?	1 2 3 4 5
10.2 At household level how do you cope with these challenges?	1 2 3 4 5
10.3What is the household's level of human capital when your water point has broken down?	1. High 2. Medium 3. Low
10.4 What is the household's level of social capital when there is a breakdown?	1. High 2. Medium 3. Low
10.5 What is the household's financial capital when there is a breakdown?	1. High 2. Medium 3. Low
10.6 What is the household's physical capital when there is a breakdown?	1. High 2. Medium 3. Low
10.7 What do you think should be done to improve sustainability of your water point	1 2 3 4 5

Thank you for your time

Appendix 3.3: Key Informant Interview Guide: District

District	Organisation	Position of respondent

Introduction and purpose of the interview:

Good morning/afternoon. My name is Mrs Tendai Kativhu I am conducting a survey on water supply services in this area. The purpose of the survey is to assess sustainability of water supply services. The data which will be collected through the survey will be used to advice the government of Zimbabwe and other relevant organisations to improve sustainability of water supply services in your area. Your district has been selected to participate in this study.

Confidentiality and Consent: This survey will not collect information that can be used to identify you as an individual. You are free to participate or to choose not to participate in this survey. If at any time during the interview you feel you no-longer want to continue with the interview please inform the interviewer who will stop the interview at that moment. Your answers to the questions that you will be asked will not be revealed to anyone except the research team. You are free not to answer questions that you are not comfortable answering. You will not be contacted by any one concerning the answers you give. The interview will take approximately 45 minutes.

To show your consent please sign in the space below.

I certify that the purpose of this research has been explained to me.

Signature:...

Date..............................

1. Who are the major water supply service providers in this district?

Probes

- NGOs and water supply services they offer
- Government water supply projects

2. What water supply problems do communities face in this district?

Probes

- Water scarcity, quality
- Non functional and unreliable water points
- Distance to water points
- Queuing

3. As an organisation, what is your role in the water supply sector?

4. When organisations implement water supply projects in your district, how do communities participate?

Probes

- Participation of local communities (in planning, implementation, management and monitoring)

5. What factors affect the sustainability of water points in this community?

Probes

- Technology (reliability and condition of water system)
- Social aspects (community participation, social inclusion, conflict management and participation of men and women)
- Financial issues (adequacy and transparency of financial contributions, accessibility of the District Revolving Fund, regularity of fee collection)
- Institutional (existence and functioning of management structures, do they give external support to communities, do they have TORs, are they aware of their roles and responsibilities, training and its adequacy, are spares readily available, capacity of District Maintenance Team, coordination and linkage of institutions)
- Maintenance (existence and functioning of maintenance committee, capacity of maintenance committee, does the district offer support to communities in times of major breakdowns)
- Monitoring (community monitoring, monitoring by external institutions)

- Spare parts supply (availability and affordability of spare parts)

6. Of all the factors discussed above which ones are the most influential in affecting sustainability of water supply?
7. May you describe the institutions at district and community level in water supply in the district.
    - Which ones are functioning?
    - Are they trained and how do they link to other development structures?
    - Are there TORs for the management structures?
    - Are the institutions aware of their roles and responsibilities?
    - What is the membership structure of the institutions?
8. Presence of VPMs
    - Training, capacity, equipment for VPMs
    - Are there records of the performance of water points
9. Existence of the District Revolving Fund
    - Is the revolving fund established and active at Council?
    - Are communities aware of the existence of the revolving fund?
    - Do communities access it?
10. Community planning
    - Are there development plans at local level?
    - Was the community involved in prioritising activities included in the plan?
    - Are the plans reviewed and updated regularly?
    - Are the plans being implemented?
    - Are communities aware of the need to have their plans included in District plans?
11. Multiple uses of water
    - Which productive uses are being practised using drinking water points?
    - What are the benefits of multiple uses of water?
    - What are the impacts of multiple uses of water on sustainability of water supply systems
12. CBM implementation
    - What is your understanding on CBM?
    - How are you implementing CBM?
    - Are you aware of the CBM implementation framework and are you using it?
    - Are other stakeholders implementing CBM as prescribed by the guiding framework?

13. What do you think should be done to improve the sustainability of water supply services in your district?

Thank you for your time

Appendix 3.4: Interview Guide: Key Informant Interview Guide: Ward

District	Ward	Organisation	Position of respondent

Introduction and purpose of the interview:

Good morning/afternoon. My name is Mrs Tendai Kativhu I am conducting a survey on water supply services in this area. The purpose of the survey is to assess sustainability of water supply services. The data which will be collected through the survey will be used to advice the government of Zimbabwe and other relevant organisations to improve sustainability of water supply services in your area. Your ward has been selected to participate in this study.

Confidentiality and Consent: This survey will not collect information that can be used to identify you as an individual. You are free to participate or to choose not to participate in this survey. If at any time during the interview you feel you no-longer want to continue with the interview please inform the interviewer who will stop the interview at that moment. Your answers to the questions that you will be asked will not be revealed to anyone except the research team. You are free not to answer questions that you are not comfortable answering. You will not be contacted by any one concerning the answers you give. The interview will take approximately 45 minutes.

To show your consent please sign in the space below.

I certify that the purpose of this research has been explained to me.

Signature:..

Date..............................

1. Who are the major water supply service providers in this ward?

Probes

- o NGOs and water supply services they offer
- o Government water supply projects

2. What water supply problems do communities face in this ward?

Probes

- o Water scarcity, quality
- o Non functional and unreliable water points
- o Distance to water points
- o Queuing

3. As an organisation, what is your role in the water supply sector?

4. When organisations implement water supply projects in your district, how do communities participate?

   Probes

   - o Participation of local communities (in planning, implementation, management and monitoring)

5. What factors affect the sustainability of water points in this community?

Probes

- o Technology (reliability and condition of water system)
- o Social aspects (community participation, social inclusion, conflict management and participation of men and women)
- o Financial issues (adequacy and transparency of financial contributions, accessibility of the District Revolving Fund, regularity of fee collection)
- o Institutional (existence and functioning of management structures, do they give external support to communities, do they have TORs, are they aware of their roles and responsibilities, training and its adequacy, are spares readily available, capacity of District Maintenance Team, coordination and linkage of institutions)
- o Maintenance (existence and functioning of maintenance committee, capacity of maintenance committee, does the district offer support to communities in times of major breakdowns)
- o Monitoring (community monitoring, monitoring by external institutions)
- o Spare parts supply (availability and affordability of spare parts)

6. Of all the factors discussed above which ones are the most influential in affecting sustainability of water supply?
7. May you describe the institutions at district and community level in water supply in the district.

- Which ones are functioning?
- Are they trained and how do they link to other development structures?
- Are there TORs for the management structures?
- Are the institutions aware of their roles and responsibilities?
- What is the membership structure of the institutions?

8. Presence of VPMs
   - Training, capacity, equipment for VPMs
   - Are there records of the performance of water points
9. Community planning
   - Are there development plans at local level?
   - Was the community involved in prioritising activities included in the plan?
   - Are the plans reviewed and updated regularly?
   - Are the plans being implemented?
   - Are communities aware of the need to have their plans included in District plans?
10. Multiple uses of water
    - Which productive uses are being practised using drinking water points?
    - What are the benefits of multiple uses of water?
    - What are the impacts of multiple uses of water on sustainability of water supply systems
11. CBM implementation
    - What is your understanding on CBM?
    - How are you implementing CBM?
    - Are you aware of the CBM implementation framework and are you using it?
    - Are other stakeholders implementing CBM as prescribed by the guiding framework?
12. What do you think should be done to improve the sustainability of water supply services in your district?

Thank you for your time

Appendix 3.5 Focus Group Discussion Guide

District ………...................	Ward ....

Introduction and purpose of the interview:

Good morning/afternoon. My name is Mrs Tendai Kativhu I am conducting a survey on water supply services in this area. The purpose of the survey is to assess sustainability of water supply services. The data which will be collected through the survey will be used to advice the government of Zimbabwe and other relevant organisations to improve sustainability of water supply services in your area. Your ward has been selected to participate in this study.

Confidentiality and Consent: This survey will not collect information that can be used to identify you as an individual. You are free to participate or to choose not to participate in this survey. If at any time during the interview you feel you that, you no-longer want to continue with the interview please inform the interviewer who will stop the interview at that moment. Your answers to the questions that you will be asked will not be revealed to anyone except the research team. You are free not to answer questions that you are not comfortable answering. You will not be contacted by any one concerning the answers you give. The interview will take approximately 45 minutes.

To show your consent please sign in the space below.

I certify that the purpose of this research has been explained to me.

Signature:...

Designation......................................

Date..............................

1. What are the major sources of water in this community?

Probes

- Who implemented these sources?
- Are these sources supplying adequate water for household needs for the community?

2. What water supply problems are you facing in this community?

Probes

- Water scarcity, quality
- Non functional and unreliable water points
- Walking long distances
- Queuing

3. What factors affect the sustainability of water points in this community?

Probes

- Technology (reliability and condition of system)
- Social aspects (community participation, social inclusion, conflict management and participation of men and women)
- Financial issues (adequacy and transparency of financial contributions, accessibility of the District Revolving Fund, regularity of fee collection)
- Institutional issues (existence and functioning of user committees, capacity of VPMs, coordination and linkage of institutions)
- Maintenance (existence and functioning of maintenance committee, capacity of maintenance committee)
- Monitoring (community monitoring, monitoring by external institutions)
- Spare parts supply (availability and affordability of spare parts)
- Vulnerability (community and household human, physical, social and financial capital)

4. Of all these factors which ones are the most influential in affecting sustainability of water supply facilities?
5. Community planning
   - Are there development plans at local level?
   - Was the community involved in prioritising activities included in the plan?
   - Are the plans reviewed and updated regularly?
   - Are the plans being implemented?
   - Are communities aware of the need to have their plans included in District Plans?
6. Multiple uses of water?

- What are the multiple uses of water being practiced in the community?
- What are the benefits of multiple uses of water?
- What are the impacts of multiple uses of water on sustainability?

7. Where water supply is not sustainable what problems do communities face? The old, child headed families, PLWHA, people living with disabilities, women, girls.
8. What strategies do communities use to overcome these problems?

Probes

- Poor households
- Vulnerable households
- Rich households

9. Do communities/households have the coping capacity to problems associated with unsustainable services?

   Probes

   - Human capacity
   - Physical capacity
   - Financial capacity
   - Social capacity

10. What do you think should be done to improve the sustainability of water supply services in your community?

Thank you for your time