HOUSEHOLD WATER SECURITY IN DIFFERENT SETTLEMENT CATEGORIES OF NGAMILAND DISTRICT, BOTSWANA

DOCTOR OF PHILOSOPHY

(OKAVANGO RESEARCH INSTITUTE OF THE UNIVERSITY OF BOTSWANA)

BY

KRASPOSY KUJINGA

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Statement of Originality

The work contained in this thesis was carried out and completed by me at the Okavango Research Institute of the University of Botswana between June 2011 and May 2014. I hereby declare that this study constitutes my original work and has never been submitted for the award of a degree or diploma to any University. To the best of my knowledge this thesis contains no material written by another person except where due reference is made in the thesis itself.

Author's signature: _____

Date: 02/10/15

Dedication

This work is dedicated to the following extra-ordinary people in my life:

My late father, Kujinga Shava Mushumani, a man who lived in abject poverty during his childhood, but worked hard and ensured that his children attain the level of education which he could not attain himself.

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Contents

Abstract

Globally, water security is under severe pressure as a result of a complex interplay of factors that include hydrological conditions, rapid population growth, rural-urban migration, increased per-capita water use, pollution of water resources, over-abstraction of groundwater, climate change and climate variability. Households in different settlement categories of Ngamiland, Botswana, experience water insecurity. There have not been many studies in Ngamiland which focus on water security in all the different settlement categories as done by this study.

The study advances knowledge on water security in different settlement categories of Ngamiland, factors affecting water security, household coping and adaptation strategies, gender and social dimensions of household water security and the impact of water governance on household water security. The general objective of the study was to explore and understand household water security in different settlement categories of Ngamiland. The specific objectives of the study were: i) to explore and analyse household water security challenges in different settlement categories of Ngamiland; ii) to analyse factors contributing to water security challenges and threats in different settlement categories of the Ngamiland; iii) to analyse the coping and adaptation strategies to water insecurity by households in different settlement categories of Ngamiland; iv) to analyse gender and other social dimensions of household water insecurity in Ngamiland; v) to analyse water governance and household water security in Botswana. The concepts of security, water security, human security, water governance as well as the integrated water resource management approach and the actor-oriented approach were used in the analysis of household water security in different settlement categories of Ngamiland. The study was non-interventional, analytical and undertaken through the collection of qualitative data, water quality data and quantitative data which was collected through a cross-sectional survey of 554 households in eight villages. Secondary data sources supplemented primary data.

The results show that there is household water insecurity across the different settlement categories (that is, primary, tertiary and ungazetted) of Ngamiland. Gazetted settlements frequently go for prolonged periods of time without receiving water supply services which they are entitled to. Micro-biological tests show that the water from across the different

settlement categories is not suitable for drinking as it contains some micro-biological counts. Several factors contribute to water insecurity in different settlement categories of Ngamiland. These include Botswana's settlement policy, climatic, hydrological, technical, socio-economic and financial factors. When households from different settlement categories face water insecurity, they are not passive actors but actively devise coping or adaptation strategies aimed at ensuring household water availability. Household water insecurity has gender and other social dimensions. Women and girls physically bear the brunt of water insecurity through spending prolonged periods of time fetching water which they carry in containers loaded on their heads. Other social dimensions of water insecurity in households include the use of various assets (for example, small containers which can be head-loaded, donkey-drawn carts, or light vehicles), rainwater harvesting, personal hygiene and the inter-personal politics of fetching water from neighbours' standpipes. Water security in Botswana is negatively affected by the fact that the country still uses a legal framework which does not capture current water governance principles such as IWRM which are aimed at enhancing water security.

Water insecurity in different settlements has to be addressed through policy interventions and strategies (i.e. short, medium and long term) which need to be underpinned by scientific research. The state has to adopt more effective planned intervention policies aimed at enhancing household water security in different settlement categories. Botswana has to come up with water legislation and a policy framework which reflects the current operating environment as well as current water governance approaches to enhance household water security.

CHAPTER ONE

Chapter One

1. Introduction

1.1. Background and Context

Globally, water security is under severe pressure as a result of a complex interplay of factors that include hydrological conditions, rapid population growth, rural-urban migration, increased per-capita water use, pollution of water resources, over-abstraction of groundwater and climate change (Jones, Vardianian, & Hakopian, 2009). More than 1.1 billion people at the global level lack access to safe water supply and 2.6 billion people lack adequate sanitation (UNESCO, 2009; World Water Council, 2000). As many as 51% of the people in sub-Saharan Africa lack access to a safe supply of water and 41% lack adequate sanitation (UNDP, 2006). By 2025, 16% of Africa's population is expected to be subjected to water scarcity. In Southern Africa, essential water resources are becoming limited and fragile, thereby threatening water security (Clarke, 2013).

Botswana is equally threatened by water security challenges as a result of limited freshwater resources, urbanisation, potential negative impacts of climate change/variability, inadequate/imperfect water policies, relatively ineffective water governance, demographic changes, over-abstraction of ground water resources and deteriorating water quality (Botswana Department of Environmental Affairs, 2006; Swatuk & Kgomotso, 2007; Ngwenya and Kgathi, 2006; Raum et al, 2011). Communities throughout Botswana encounter problems of inadequate water supply, and/or poor water quality (Mazvimavi & Mmopelwa, 2006; Mbata, 2006; Ngwenya and Kgathi, 2006; Swatuk & Kgomotso, 2007; Hope & Edge, 1996). These challenges are happening at the backdrop of high temperatures, drought and periodic flooding in basins such as the Okavango (Mendelsohn et al., 2010; Todd et al., 2008). High temperatures and drought negatively affect the quantity of freshwater resources while flooding has the potential to pollute water resources which households access. Due to high temperatures in summer, Ngamiland experiences high evapo-transpiration (ET). For example, the Okavango Delta experiences, on

average, an ET of 14 600 Mm^3/a against an inflow of 10,000 Mm^3/a and a rainfall of 5000 Mm^3/a (HOORC, 2007).

Water governance challenges being experienced in Botswana are quite varied. They range from inadequate financing mechanisms for the water sector, human resources constrains and ineffective laws and policies to overall development plans and operations (Rahm and Swatuk, 2006; Swatuk & Kgomotso, 2007; Toteng, 2002).

Given that there are signs of water security challenges in Botswana, systematic scientific research can enhance the generation of data that can reveal the extent and causes of the challenges and their impact on households, coping and adaptation strategies employed by households, gender and other social dimensions of water insecurity and the nature and type of water governance in Botswana in general and Ngamiland region in particular. This study sought to understand and analyse water security issues in Ngamiland from the perspective of households.

1.2. Problem Statement

Lack of access to safe and clean water is a major global concern. At the global level, over 1.1 billion people lack access to safe water supply and 2.6 billion people lack adequate sanitation (UNESCO, 2009; World Water Council, 2000). With regards to Africa, nearly 51% of the people in sub-Saharan countries lack access to safe water supply and 41% lack adequate sanitation (Jones, 2009). Fourteen countries in Africa are currently experiencing water stress and the number is expected to rise to 29 by 2025 (Hirji, Johnson, & Matiza-Chiuta, 2002). Approximately 16% of the continents' population (230 million) may be subjected to water scarcity by 2025.

Botswana has made positive strides in the provision of safe and clean water to its population since gaining independence in 1966. The percentage of the population with access to improved water sources is 97% (Central Statistics Office, 2009). Such a high percentage gives the impression of a country that is on the verge of achieving water security. This often quoted national percentage masks the reality of water security challenges being faced at the local level, especially by households in areas such as Ngamiland. This percentage is based on the mere

presence of improved water sources as opposed to the functionality as well as the quality of the water of such sources. Although gazetted settlements in Botswana are entitled to water supply services, a number of these in Ngamiland have over the years been experiencing unreliable and unpredictable domestic water supply services (Mazvimavi & Mmopelwa, 2006; Ngwenya & Kgathi, 2003; Swatuk & Kgomotso, 2007). Households in settlements classified as ungazetted mainly access water from untreated sources. Of all the settlements in Ngamiland, 33% are classified as ungazetted, and households in these areas have to meet their own domestic water needs (Mazvimavi & Mmopelwa, 2006). This means, therefore, that a significant number of households are without access to a reliable supply of clean water. It is not well documented how these households meet their water needs during different times of the year. There has not been much systematic research aimed at investigating and documenting the extent of water security challenges faced by households in both gazetted and ungazetted settlements, factors behind water security challenges experienced by households, coping and adaptation strategies employed by households from different settlement categories, gender and other social dimensions of water insecurity experienced and the impact of water governance approaches on household water security.

A number of factors can interact to cause water insecurity experienced by households in different settlement categories of Ngamiland. There is currently limited research and literature on the interactions between and among different factors (e.g. hydrological, climatic, demographic, policy/governance, technical and socio-economic development) which contribute to household water insecurity in Ngamiland. Furthermore, issues related to household coping and adaptation mechanisms in response to water security challenges have not been subjected to research. Water insecurity also has gender and social dimensions which have not yet been adequately interrogated. The contribution of the current water governance framework to household water insecurity has not yet been investigated and adequately documented. This reveals limited research in the area of water security in Botswana.

While Botswana subscribes to the concept of IWRM, there has not been much research with regards to how this approach is being implemented and how it is enhancing water security among communities in Ngamiland. This is partly due to legislation and policy instruments that

are still silent on IWRM principles. The study sought to understand progress that has been made in adopting IWRM principles and how this has impacted on household water security.

The study contributes to the existing research/literature on household water security by generating knowledge on water security in Ngamiland. Research in Botswana can play a crucial role in informing policy to put more emphasis on water security. Recommendations on enhancing water security for policy purposes in Botswana are offered.

1.3. Objectives of the Study

1.3.1. General objective

The general objective for the study was to explore and understand household water security in different settlement categories of Ngamiland.

1.3.2. Specific objectives

The following were the specific objectives of the study:

- To explore and analyse household water security challenges in different settlement categories of Ngamiland;
- To analyse factors contributing to household water security challenges and threats in different settlement categories of Ngamiland;
- To analyse the coping and adaptation strategies to water insecurity by households in different settlement categories of Ngamiland.
- To analyse gender and other social dimensions of household water insecurity in Ngamiland;
- To analyse water governance and household water security in Botswana.

1.4. Literature Review

There have been efforts as well as resolutions at the global level by the international community, including the G8 Summit, as well as the World Water Forum, to improve global water security, including water supply and sanitation, but it seems the fight is not being won (Jones et al., 2009). Despite all these efforts around the world, there are more people globally who lack safe water

and sound sanitation than there were at the turn of the 21st Century (Falkenmark & Rockstrom, 2004). The most vulnerable are people in poor countries in Asia and Africa where millions have no access to safe and centrally supplied water (Ngaira, 2007). As a result, the majority are forced to use polluted surface or groundwater (Jones et al., 2009). It has been pointed out that in the 21st Century, there are still large numbers of people, especially women and children in the developing world, who are forced to collect untreated water from various sources, often having to walk great distances to reach them (Falkenmark & Rockstrom, 2004). Such a development failure cannot be directly attributed to the physical scarcity of water, but rather to poor governance (Abrams, 2001; Falkenmark & Rockstrom, 2004; Gleick, Wolff, Chalecki, & Reyes, 2002).

1.4.1. Water security in Southern Africa

Water security is emerging as one of the highest priorities on the global development agenda, but one of the least explored in terms of research. Water security is a basic human right at the heart of a daily crisis faced by millions of people in the world's most vulnerable countries in Africa and Asia (Jones et al., 2009; UNDP, 2006). The water security crisis confronting the world threatens life and has the potential to destroy livelihoods on a devastating scale (Buzan et al., 1988; UNDP, 2006). Overcoming the global water security crisis is one of the greatest human development challenges of the early 21st Century (UNDP, 2006). Clean water and sanitation are among the most powerful drivers for human development as they extend livelihood opportunities, enhance dignity and help create a virtuous cycle of improving health and rising wealth (UNDP, 2006).

Water security enhanced social progress in today's developed countries whereas in the late 19th Century, cities such as London, New York and Paris were, due to water insecurity, centers of infectious disease, such as diarrhoea, dysentery and typhoid fever, which undermined public health (UNDP, 2006). Reforms in water and sanitation changed this picture, as clean water became the vehicle for human progress (UN, 2006). A series of social reforms, coupled with moral concern and economic self-interest embarked on by governments in the western world where water and sanitation were placed at the centre of their development agenda dramatically changed water supply and sanitation (UNDP, 2006). Within a generation, they managed to put in

place the finance, technology and regulations needed to bring water and sanitation for all within reach.

At the regional level, an estimated 100 million people in the Southern African Development Community (SADC) lack access to safe water for drinking and household use (SADC, 2012). Three quarters of those who lack access live in rural areas and are predominantly women and children (Hirji et al., 2002; MacDonald & Ruiters, 2005). In the Democratic Republic of Congo (DRC), for instance, more than 75% of the population lack access to potable water (Boisson et al., 2010). This is despite the fact that the DRC possesses half of the water resources of Africa. With regards to Mozambique, water supply coverage is at 43%, while Zimbabwe is at 81% (Mushizhi, 2010). In terms of the global figures related to access to clean water, Botswana is ahead of many Southern African countries.

In Botswana, the proportion of the population without access to safe drinking water, a key Millennium Development Goals (MDGs)[1] indicator, is currently quoted as 4% (Botswana Department of Environmental Affairs, 2006). Such a percentage appears to be a good record for a developing country which has been able to use its income based on diamond exports to facilitate the supply of water (Swatuk & Kgomotso, 2007). The country has been able to provide water services to a large part of its citizenry mainly because 80% of the population is clustered within 50 km of the Lobatse-Francistown road, where the multi–billion dollar North South Water Carrier was built to facilitate access to water (Swatuk & Kgomotso, 2007).

1.4.2. The concept of water security

The concept of water security encompasses issues of water availability, accessibility, quantity, quality, affordability, distribution and usage. A number of published studies have traditionally envisaged availability as the central focus (Ariyabandu, 2001), although availability alone does not ensure household water security at a given point in time. The concept of water security can be used differently in different contexts (Grey & Sadoff, 2007). The term cannot be defined along the same lines as "food security" and "energy security" which generally mean reliable

[1] The Millennium Development Goals (MDGs) are eight international development goals that all 193 United Nations member states and at least 23 international organizations have agreed to achieve by the year 2015. They include eradicating extreme poverty, reducing child mortality rates, fighting disease epidemics such as AIDS, enhancing environmental sustainability and developing a global partnership for development.

access to sufficient supplies of food or energy, respectively. A striking difference, however, is that unlike food or energy, it is not just the absence of water but also its presence and quality that can be a threat to human and environmental security (Grey & Sadoff, 2007; Lautze & Manthrithilake, 2014). This destructive quality of the resource in its natural, unmanaged state is arguably unique.

Water security has been defined differently from different perspectives. One definition presents it as the sustainable access to adequate quantities of water of acceptable quality to ensure human health (Ribot & Peluso, 2003). The other definition presents it as access to adequate safe water by all individuals at all times for health and productive life (Webb & Iskandarani, 1998). The Global Water Partnership (GWP) defines water security as a central objective where every person has access to enough safe water at affordable costs to lead a clean, healthy and productive life while ensuring that the environment is protected (GWP, 2000b). Though the above definitions can be considered as appropriate, they do not take into consideration the destructive aspect of water resources which can be a threat to water security (Grey & Sadoff, 2007: 547). Taking this into consideration, water security can be defined as "the sustainable access and availability of an acceptable quantity and quality of water for health, livelihoods, ecosystems and production, coupled with an acceptable level of water related risks to people, environments and economies" (Grey & Sadoff, 2007).

One of the weaknesses of the water security concept is that it is largely qualitative, that is, it has not been quantified. Quantifying the term can i) encourage clarity and common understanding of a concept around which there currently exists substantial ambiguity; ii) help to set a scale and thresholds for evaluating the presence, absence or degree of water security; and iii) assess the extent to which the concept is being achieved on the ground (Lautze & Manthrithilake, 2012).

1.4.3. Dimensions of water security

Households require water on a daily basis for different purposes such as drinking, cooking, personal hygiene, cleaning of the house, washing clothes and watering small gardens and drinking for livestock. There are several dimensions (of water security) which have to be

fulfilled if water security is to be achieved. These can be explained, among other issues, in terms of water availability, accessibility and quality and quantity of the resource.

1.4.3.1. Water availability

Water availability for individuals and households is one of the determinant factors of water security. At the global level, freshwater resources account for only 2.5% of the earth's water, and most of it is frozen in glaciers and ice caps (UNEP, 2010). The remaining unfrozen freshwater is mainly found as groundwater, with only a small fraction present above ground or in the air. The surface freshwater resources found in rivers, lakes and in the ground are declining due to such factors as urbanisation, pollution, demographic changes and socio-economic development (Middleton, 2013). There is also an uneven distribution of the available freshwater resources found on earth. Africa's 3,931 km^3 of renewable water resources represent around 9% of the world's total freshwater resources (Michael, 2008). South America and Asia have the highest proportion of water, each with 28.3%, followed by North America with 15.7%, and Europe with 15% (Young, Dooge, & Rodda, 2004).

There are wide variations in average water availability per person among countries in Africa, given that different countries are in different categories of water availability. A number of countries in Africa are now classified as either water vulnerable, stressed or scarce (Brown & Matlock, 2011). Water vulnerability refers to a situation whereby 1,700 m^3 – 2,500 m^3 of water is available to each person per year in a particular country (Rijsberman, 2006; UNDP, 2006). Water stress is whereby the per capita available water resources are in the range of 1000 m^3 to 1,700 m^3 per capita per year while water scarcity[2] is a situation whereby the available water resources per capita are less than 1,000 m^3/year (UNDP, 2006). By 1990, countries such as Ethiopia, Zimbabwe and Mauritius were already classified as water vulnerable and are projected to be in the water stress category by 2025 (van der Zaag, 2006). South Africa, Egypt and Malawi were classified as water stressed in 1990 and will all be in the scarcity region by 2025. Kenya,

[2] Water scarcity is categorised into physical and economic. Physical water scarcity is the situation where there is not enough water to meet all demands, including that needed for ecosystems to function effectively. Arid regions frequently suffer from physical water scarcity. Water scarcity also occurs where water seems abundant, but where resources are over-committed. This can happen where there is overdevelopment of hydraulic infrastructure, often for irrigation purposes. Symptoms of physical water scarcity include environmental degradation and declining groundwater. Economic water scarcity is caused by a lack of investment in water infrastructure or insufficient human capacity to satisfy the demand for water.

Burundi and Rwanda were already water scarce by 1990 and these will move deeper into the scarcity category by 2025 (Showers, 2002).

1.4.3.2. Access to water

Access to water resources is very crucial for households if they are to fulfil their daily water requirements. Access can be defined as the ability to derive benefits from particular resources (Ribot & Peluso, 2003). There are two complementary dimensions of access which are considered when dealing with this concept. These are access control and access maintenance. Control refers to the function or power of directing and regulating free action (Rangan, 1997 in Ribot and Peluso, 2003), while maintenance refers to the requirements to keep a resource open and maintained in a proper state that will enable utilisation by everyone who is supposed to benefit from its use (ibid). In the case of water resources, access is determined by the physical and technological dimensions, that is, the means used to get water from the source to the place of consumption (Howard & Bartram, 2003). This includes the infrastructure, technology, technical knowledge and also the topography of the area (Izquierdo, 2010). Access also depends on the governance structures in place. These include the legal frameworks that define access or authorisation. The organisational component of governance is concerned with issues related to policies, laws and institutions that mediate access as well as making decisions on allocation, water distribution, as well as operating and maintenance of water resources (GWP, 2000a). Good governance is tightly linked to the role of stakeholders in the management, use and allocation of the resource.

Access to water for household use is also determined by factors that include pricing and affordability. It is now accepted among water resource managers that water should be considered an economic good, whereby all users have to meet the costs of supply (Savenije & van der Zaag, 2002). This is supported by the Rio-Dublin fourth Integrated Water Resources Management (IWRM) principle which states that water has an economic value and should be recognized as an economic good, taking into account affordability and equity criteria (GWP, 2000a). Water pricing is seen as an instrument to achieve financial sustainability. An activity such as water supply can only be sustainable if the financial costs are recovered from those accessing and using

the resource. If the service is provided for free, the service provider will not be able to maintain the supply chain and this will eventually lead to the collapse of the system (Savenije & van der Zaag, 2002). On the other hand, the status of the poor who cannot afford high water prices has to be taken into consideration when considering water as an economic good.

1.4.3.3. Quantity of the water

The quantity of water used by households is an important aspect of water security as this determines health and hygiene. The World Health Organisation (WHO) does not have guidelines on the quantity of domestic water that is required to ensure water security by an average household globally or in different continents. The MDGs include a target to "halve the proportion of people who are unable to reach or to afford safe drinking water by 2015" (UN, 2013), but it does not specify the quantity of water to be supplied. Botswana's water legislation and its policies do not specify the amount of water that a particular household requires on a daily basis to satisfy its needs. The Water Act of South Africa allocates 25 litres of water for free per person per day or 6 kilolitres per household per month (McCaffrey & Neville, 2008). This amount of water is meant to cover for all the domestic purposes. Despite this being the case, the WHO/UNICEF Joint Monitoring Programme, which produces the Global Assessment of Water Supply and Sanitation data, describes reasonable access as availability of at least 20 litres of water per person per day from a source within one kilometre of the user's dwelling (WHO/UNICEF, 2000). It is important that households should have access to adequate water for their domestic needs.

The quantity of water available and accessed by a particular household is determined by a number of factors that include distance (where water is purchased), time and cost to the consumer, reliability of supply and cost to the service provider (Howard & Bartram, 2003). Low-income families are likely to be at greater risk from poor water supply as they have more limited capacity for storing large volumes of water at home (Zerah, 2000). This can lead to the use of smaller volumes of water for different domestic purposes such as cooking, bathing and general cleaning.

1.4.3.4. Quality of water

In view of the complexity of factors that determine water quality, and the large choice of variables used to describe the status of water resources in quantitative terms, it is difficult to provide a simple definition of water quality. Moreover, the term *water quality* is to a greater extent nebulous and often used without being properly defined (Boyd & Tucker, 1998). Furthermore, the understanding of water quality has evolved over the last 100 years as a result of the expansion of water use requirements and the ability to measure and interpret water characteristics (Chapman, 1996). Two definitions of water quality which are almost similar will be used in this study. Firstly, the term can be defined as the summary of physical, chemical, biological and aesthetic characteristics of water that impact on its beneficial use (Boyd & Tucker, 1998). Secondly, water quality is defined in this study as the physical, chemical and biological characteristics of water in relation to the existence of life and especially human activity (Machiwa, 2003). There is broad agreement that good water quality, especially free of pathogens, is important to human health (Trevett, Carter, & Tyrrel, 2005).

WHO Guidelines and the national drinking water standards of the majority of the countries, take the presence of *Escherichia coli* (*E. coli*) thermotolerant coliforms as an indication of recent faecal pollution from human or warm-blooded animals (WHO, 2011). Thus, the WHO Guidelines value of zero *E. coli* or thermotolerant coliform bacteria in any 100 ml sample of drinking water was established because even low levels of faecal contamination may potentially contain pathogens (WHO, 1993).

The quality of water is a crucial element in domestic water security. Not only is the availability of the resource necessary, but also an acceptable level of quality that allows its use for different purposes without negatively affecting the health of human beings, animals or the environment should be guaranteed (Machiwa, 2003). In many parts of the world, human health is threatened either from lack of water or poor water quality. Human development has partially contributed to water quality deterioration. Population growth has led to the expansion of agricultural activities, livestock keeping, deforestation, biomass burning and human settlement, and has in return exerted pressure on water sources across the world, especially in African countries such as

Tanzania, South Africa, Kenya and Uganda (Machiwa, 2003). Such developments have led to land degradation and increased levels of pollution, mainly from non-point sources.

Water supply in rural communities is associated more frequently with waterborne diseases than in urban areas (WHO, 2009). WHO considers safe water as the one that does not present any significant risk to the health of those people who consume it (WHO, 2008).

With regards to Botswana, which still needs a wide baseline data on water quality, the provision of water that meets the country's water quality standards remains a challenge. This is mainly due to salinity of groundwater resources, pollution of sources, high operation and maintenance costs of desalination plants and utilisation of inappropriate and complex technology (Ministry of Finance Development and Planning, 2009). In places where the government does not supply potable water, communities rely mainly on unprotected river water for domestic purposes, including drinking (Kgomotso & Swatuk, 2006). Water from such sources has objectionable attributes such as particles, unpleasant odour and an offensive colour (Mazvimavi & Mmopelwa, 2006). In order to improve its quality, a number of households in some villages are involved in boiling, settling and sieving the water (Kgomotso & Swatuk, 2006).

Maun Village, which is the only primary centre in Ngamiland, has problems of poor water quality related to high salinity, which tends to increase with the depth of the boreholes (Geoflux, 2002; Mmopelwa, Kgathi, Masamba, & Thukuza, 2008). It has been observed that deep boreholes tend to have ample water supply but of poor quality. The Total Dissolved Solids (TDS) for the water supplied to residents of Maun Village are sometimes higher than what is regarded as permissible. The maximum levels of TDS allowable by WHO standards are 1000 mg/l. One of the problems causing high concentrations of TDS in borehole water in Maun Village, is the low precipitation and high evapotranspiration occurring in Ngamiland as a whole (Plantec Africa, 2003). High rainfall reduces the concentration of TDS through groundwater recharge, which freshens groundwater resources in the aquifer (Doody, Holland, Benyon, & Jolly, 2009; Mmopelwa et al., 2008; Ravenscroft, McArthur, & Hoque, 2013). On the contrary, surface water resources from the Thamalakane River were found to be of generally acceptable

quality, though in some cases guidelines for pH and electrical conductivity, set by the Botswana Bureau of Standards (2000), are exceeded (Masamba & Mazvimavi, 2008).

1.4.4. Water security in Botswana

Over the years, threats to water security in Botswana have manifested themselves through increased water demand as a result of urbanisation, changing lifestyles, challenges in groundwater resources which supply 80% of the country, limited surface water resources and water governance related challenges such as outdated water legislation and multiple institutions tasked with water provision (Kujinga., et al., 2014). About 60% of Botswana's population live in urban areas which are defined as settlements of over 5000 people with 75% of them involved in non-agricultural activities (Botswana Department of Environmental Affairs, 2006; Central Statistical Office, 2009). Most of the urban dwellers prefer private water connections which, in most cases, are associated with high water usage. There is competition for water resources between and among sectors such as domestic, livestock, crop production, tourism and mining. The overall demand for freshwater resource has been rising over the years and is projected to continue increasing. It was projected that demand for the country would increase by 74% between 2000 and 2020 from 193.4 Mm^3/year to 336 Mm^3/year (Swatuk & Rahm, 2004). The country does not have much surface water resources to exploit as four of the five basins (i.e. Limpopo, Okavango, Orange and Zambezi) are shared watercourses and are subject to the SADC Protocol on Shared Watercourses.

In terms of perennial rivers, Botswana only has two, which are, Okavango and Chobe Rivers, and are both situated in the north of the country. Besides the perennial rivers, Botswana has a number of ephemeral rivers that provide sites for dams. Water from dams and rivers contributes about one-third to national water consumption while 66% of the country relies on groundwater supplies (Central Statistical Office, 2009). Botswana is supplied with water from seven major dams with a combined capacity of 1106.25 Mm^3 (see Table 1).

Table 1: Botswana's major dams

Name of Dam	**Capacity Mm^3**	**23/06/14 level (%)**	**June 2015 level (%)**	**Months of supply without inflow**	**Location**	**Area supplied**	**District**
Gaborone	141.1	12	2	Failed	Gaborone	Greater Gaborone	South East
Bokaa	18.5	45	7	2	Bokaa		Kgatleng
Nnywane	2.3	55	72	10	Lobatse	Lobatse	South East
Shashe	85	90	94	22	Shashe	Greater Francistown	North East
Letsibogo	100	90	53	14	Mmadinare	Greater Gaborone, S/Phikwe, BCL and Mmadinare	
Molatedi[3]	201	33	11	20	RSA	Greater Gaborone	Central
Ntimbale	26	95	94	15	Tutume	NE Tutume District	North East
Dikgatlhong	400	96	-	-	35 mi northeast of Selebi Phikwe	-	Central
Lotsane	42.35	90	22	22	Southeast of Botswana	-	Central
Thune	90	59	-	-	Central District	-	Central
Total	**1106.25**						

Source: (Water Utilities Corporation, http://www.wuc.bw/wuc-content.php?cid=109)

[3] Although Molatedi Dam is in South Africa, it supplies water to Botswana. The dam supplies 16% of its total capacity to Botswana and 8% at half capacity.

Table 1 shows that there are more dams located in the Central District while the North East and South East Districts have two dams each. This is mainly because of suitable locations for damming. Districts such as Northwest (Ngamiland), Chobe, Ghanzi and Kgalagadi do not have a single dam due to unsuitable sites for damming. However, the dams that are found in Botswana are in relatively small capacity as such as those of Namibia, another Southern African arid country (Namwater, 2014). Water from these dams is not adequate to meet demand. Botswana gets some water from Molatedi dam in South Africa in order to satisfy demand for Gaborone. The dam situation in Botswana (and Namibia) contrasts markedly with that of Zimbabwe which has over 30 major dams with individual dams such as Kyle and Osborne having capacities of 1 425 Mm^3 and 401 Mm^3 respectively (Central Statistical Office, 2009). The Kariba dam, shared between Zambia and Zimbabwe, has a total capacity of 160 368 Mm^3 (Gillett & Tobias, 2002). These dams make it possible for countries such as Zimbabwe to access surface water resources for different purposes, including domestic use.

1.4.5. Factors determining water security

The achievement of water security is determined by a number of factors which include hydrological, climatic and demographic, governance and socio-economic as well as technical factors. These factors have the potential to affect water security globally, continentally, regionally, nationally and locally, individually or interactively.

1.4.5.1. Hydrological conditions

The availability of water resources in a particular area can be heavily influenced by hydrological and environmental conditions. These factors influence inter and intra-annual rainfall variability and its spatial distribution (Lautze & Manthrithilake, 2014). Hydrological and environmental conditions are natural legacies that a particular society inherits (Grey & Sadoff, 2007; Lautze & Manthrithilake, 2014)). The hydrological and environmental conditions of many African countries can best be described as “difficult” as they are characterised by low precipitation and run-off on the one hand and periodic flooding in some years at the other extreme (Grey & Sadoff, 2007; Lautze & Manthrithilake, 2014). Rainfall is highly seasonal, punctuated by a short season of torrential rain followed by a long dry season. Such a situation usually requires a high

level of institutional management as well as investment in infrastructure in order to achieve basic water security (Grey & Sadoff, 2007; Lautze & Manthrithilake, 2014).

In Southern African savannahs, water availability sets the limit for water security as well as the amount of growth and development that can take place in the region. High temperatures in the region lead to very high evaporation rates that deplete surface water (Holmgren et al., 2003; Schulze & Maharaj, 2004). The mean daily temperatures in Botswana, for instance, range from a minimum of 5ºC in winter to a maximum of 38ºC in summer (Hambira, 2007). The high temperatures consequently affect surface water resources through high evaporation rates. The mean annual rainfall for Botswana is 450 mm, ranging from 250 mm in the southwest to a maximum of 650 $mm.yr^{-1}$ in the extreme north (Batisani & Yarnal, 2010; Bhalotra, 1987). Rainfall is becoming highly variable in Botswana. An analysis of rainfall trends for the period 1975- 2005 shows that rainfall has been decreasing on both annual and monthly basis across Botswana (Batisani & Yarnal, 2010). The number of rainy days has also decreased across the country (Central Statistics Office, 2009). There are no major mountain chains in Botswana and, therefore, spatial and seasonal variations in climate are not very complex. Over 90% of the rainfall in Botswana occurs during the summer, from November to March, mainly in the form of scattered convective thunderstorms (Du Plessis & Rowntree, 2003).

Botswana, not only suffers from a lack of surface water, but also from the fact that the major surface water resources are located far from the areas of demand and are affected by highly variable rainfall and a high evapo-transpiration rate (Central Statistics Office, 2009). This has huge cost implications for water supply to different areas of the country. The major perennial rivers and wetlands are located in the north, while the over-utilised Limpopo and its tributaries are in the east. Water resources for Botswana are generated within the basins of four major rivers and these are, the Limpopo, Okavango, Orange and Zambezi, all of which are shared with neighbouring countries (Ministry of Finance Development and Planning, 2009). Apart from the Okavango, all shared river systems flow away from Botswana. Locally generated water resources are, therefore, mainly contributed by the Okavango River Basin, which carters for a population of 158,408 and between 400,000 to 500,000 livestock (cattle, donkeys, horses, goats and sheep) (Central Statistics Office, 2011). Although the aggregate population density is low, the population is concentrated in towns and urban villages in the eastern part of the country

(Swatuk & Kgomotso, 2007). Concentration of the population in certain areas such as Maun Village results in an increase in the local demand for water and, therefore, development in such areas relies heavily on groundwater. Most of Botswana's towns and smaller settlements, rural and remote towns, the livestock industry, power stations, and most mining developments, depend mostly on groundwater which needs to be exploited in a sustainable manner since it can be depleted if it is used beyond its natural regenerative capacity (Central Statistics Office, 2009; Swatuk & Kgomotso, 2007).

1.4.5.2. Climate change, variability and water resources

Climate change and variability represent factors that are important in the 21st Century and are likely to increase the complexity and costs of ensuring water security. Overall, climate change and variability are expected to lead to reduced water availability in countries that are already water stressed and scarce (Hirji & Ibrekk, 2001). These include countries such as Zimbabwe, South Africa and Malawi.

Over the last decades, Southern Africa has experienced changes in temperature, precipitation, run-off and hydrological trends (Lobell et al., 2008). There has also been an uncharacteristic intensity and occurrence of extreme events such as floods and droughts in recent years (Barnett & Adger, 2007; Bola et al., 2014). These events have had a negative impact on water security as well as on the livelihoods of millions of people across Africa and in particular the Southern African region which depends on agriculture. Projected impacts of climate change for Southern Africa have been based on estimates of likely vulnerability of climate parameters presented in various studies conducted for the region (IPCC-WGII, 2001).

Between 1950 and 2010, summer rainfall in Southern Africa declined by 20% (Buss and Nuppenau). As a result of this, the region is already facing a problem of water stress and scarcity. The IPCC-WGII (1999, 2001) pointed out that the region will get drier as a result of climate change. Countries in the region will find it difficult to cope with the impact of climate change because the current levels of preparedness are very low. Simulations have indicated reductions in precipitation in Southern Africa for the next 100 years (Hulme, 2001). Under the base case warming scenario of 1.7°C, Southern Africa's precipitation is expected to decrease by 5-20% in all the major river basins of the region, except the Congo Basin where precipitation is expected

to increase by 10% (IPCC-WGII, 2001). Some countries may have more severe shortage in rainfall than others. Botswana and Zimbabwe may have as much as 25% and 19% shortfall, respectively (Arnell, 2004). The Congo Basin is the only Southern African basin that is projected to have an increase in rainfall and runoff under climate change (Cooper et al., 2008). This might prompt the region to plan for inter-basin water transfer to supply the drier countries in the south and east of the region in order to ensure water security.

Most of the extreme events associated with climate change and variability have exceeded the capacity of local authorities to cope with them. The current water security challenges being faced by Africa will be compounded by climate change and variability and there is need for the continent to have significant adaptation strategies in place (Barnett & Adger, 2007; Grey & Sadoff, 2007). Most African countries will find it difficult to adapt to climate change mainly because of their low levels of economic development which have seen them stuck with inappropriate institutions as well as infrastructure to manage, store and deliver water resources to the people (Grey & Sadoff, 2007).

1.4.5.3. Demographic changes and water resources

Demographic processes such as population growth, changing age structure, urbanisation and migration create some of the greatest pressures on water resources, that is, on quantity and quality (Jones et al., 2009). These processes directly affect water availability and quality through increased water demands and consumption and through pollution resulting from water use (Buhaug & Urdal, 2013). They affect water resources indirectly through changes in land use and water use patterns, with significant implications at local, regional and global levels (De Sherbinin et al., 2007).

The world's population is growing by about 80 million people a year, implying increased freshwater demand of about 64 billion cubic metres a year (Clarke, 2013). The 21st Century is estimated to see an increase in global population from 6 to 15 billion, before stabilising (UNFPA, 2011). An estimated 90% of the 3 billion people who are expected to be added to the population by 2050 will be in developing countries (UN, 2006). Apart from experiencing rapid population growth, regions such as sub-Saharan Africa, the Middle East and the Indian

subcontinent are the areas currently facing water security challenges (UN, 2006). At the same time, these regions are likely to be affected by climate change.

A greater number of governments in the developing world lack the financial resources and institutional capacity to provide for sustainable access to safe water and sanitation to a burgeoning population (Cosgrove & Rijsberman, 2014). At the same time, those third world countries that have experienced gains in terms of increased access to water supply and sanitation services since 1990 may see these gains eroded by population growth (UNDP, 2006). One of the major reasons for this will be the unprecedented scale of urban growth which will further increase water demand as well as put pressure on existing systems for water supply in cities across developing countries. In Africa and Asia, the urban population is expected to double between 2000 and 2030 (Bilsborrow, 2002). By 2030, the towns and cities of the developing world will make up an estimated 81% of urban population (UNDP, 2006).

Currently, a third of the world population live in countries suffering moderate to severe water stress and this is likely to rise to two thirds of a much larger population by 2025 (Clarke, 2013). Developing countries are the worst affected, with the poor in urban areas as well as rural areas, including children, especially girls, women and the aged being the most vulnerable (Ngaira, 2007; UNDP, 2009). Culturally, women are the ones who fetch water for household use (UNFPA, 2009). As water resources become scarce, they tend to spend many hours fetching water (UNFPA, 2009). This will be in addition to all their other duties such as cooking, looking after children and agricultural production. They will, thus, be left with few opportunities for pursuing other productive activities which can increase their resilience to natural and man-made shocks and trends (UNDP, 2009; UNFPA, 2009).

The population of Southern Africa, which stood at 175 million in 1995, is expected to rise to 322 million by 2025 (Hirji et al., 2002). While the region is growing at a rate of 3% per annum, the urban population is growing at a rate of 3.5% per annum (Hirji et al., 2002). All this will combine to put increased pressure and stress on the limited water resources as well as exacerbate competition and conflict between and among water users in the region.

According to the 2011 national census, the population of Botswana is 2,038,228 up from 1,680,863 in 2001 (Central Statistics Office, 2012). The annual population growth rate between 2001 and 2011 was 1.9% (Central Statistics Office, 2012). Such a growth rate is not being matched with adequate water supply, as in some instances demand is outstripping supply. As a result, demand for water has increased, especially in urban areas where population is growing due to urbanisation (Central Statistics Office, 2011). Increased consumption, combined with a limited national groundwater recharge rate, requires constant sinking of new boreholes, leading to a significant fall in groundwater table (Central Statistics Office, 2009). To complement underground water resources, the Government of Botswana completed the North South Water Carrier projects to transfer water from Letsibogo Dam in the north to the greater Gaborone area (Central Statistics Office, 2009).

Over 60% of Botswana's population currently live in settlements designated as urban. For a settlement to be designated as urban, it should have at least 5000 people, with at least 75% of them involved in non-agricultural activities (Gwebu, 2004). Once a settlement is designated as urban, its services (that is, water supply, health and others), physical infrastructure, utilities and telecommunications are improved. Such changes attract private sector investments as well as result employment generation.

There have also been some noticeable population changes over time in the settlements that were studied. Such changes have an effect on water demand. An increasing population in Maun Village requires water supply services in line with the population changes taking place. Table 2 highlights these changes in the settlements where data was available. Data for some years for some of the settlements could not be easily located. Demographic data for the ungazetted settlements such as Gucha, Samedupi and Xobe was not available.

Table 2: Population trends for the studied settlements

Settlement	**1971**	**1981**	**1991**	**2001**	**2011**
Maun Village	9,641	14,925	26,768	43,776	60,263
Matlapana	-	-	974	1169	1,449
Ikoga	-	342	371	375	673
Somelo	-	-	-	481	600
Ukusi	-	201	131	183	261

(Source Central Statistics Office, 2011)

1.4.5.4. Water governance

Water governance, which refers to political, social, economic and administrative systems to develop and manage water resources and water services delivery (Pahl-Wostl et al., 2010), has an impact on water security in any particular context (Tortajada, 2010). Good water governance enhances water security while poor water governance results in water insecurity. Water security can be enhanced if the water governance approach of a particular context upholds four important dimensions, i.e., social, economic, environmental and political (Ragab, 2013; The social dimension aims at ensuring access to equitable water use including water for domestic purposes for households; the economic dimension refers to efficient water use, including water pricing and water's role in economic growth; the political dimension involves granting water stakeholders and citizens equal democratic opportunities to influence and monitor political processes and outcomes, including ensuring equitable access to water for women and other socially, economically and politically weak groups and the environmental dimension involves enhancing sustainable water use and ecosystem services (Ragab, 2013). Water security can therefore be enhanced in a context where the above dimensions are supported by a sound legal and policy framework which defines the relevant and appropriate institutions for water management (Ragab, 2013; Scheumann, 2008). Such institutions need to be adequately resourced (financially, materially and in terms of the appropriate human resources) to enable them to manage and maintain the appropriate water supply infrastructure which delivers water to the different sectors on an equitable basis (Scheumann, 2008). This will ultimately enhance water security, i.e.

access to sufficient water of good quality to all sectors including households as well as the poor and marginalized groups (Ragab, 2013; Scheumann, 2008).

It is important to note that, the water sector is part of the broader social, political and economic developments and is affected by decisions outside it. As a result for governance to continue enhancing water security through good principles it needs continuous refinement and flexibility as new challenges arise (Tortajada, 2010). Good and effective water governance, further requires transparency and accountability, participatory mechanisms appropriate to local realities and respect for the rule of law and contractual obligations (GWP, 2000a). Water security is enhanced in a context where the water governance approach mandates the relevant institutions to allocate and manage water resources based on legitimate policies, laws and effective administration (Ragab, 2013; Tortajada, 2010). In a context where this is lacking, water insecurity persists. Governance, thus, encompasses many interlinked social players and must be responsive to citizens' needs and to the long term sustainability of the natural resource base of the country and region.

One of the arguments that has been advanced by organisations such as the Global Water Partnership and the United Nations is that the global water crisis is mainly a crisis of governance (GWP, 2000a). The United Nations goes further to state that there are adequate water resources for everyone globally, but the problem that is faced is the allocation of such resources (UNDP, 2006). However, the global water crisis cannot be entirely reduced to a problem of governance. It is more appropriate to argue that the governance of water resources is one of the greatest global challenges of the 21st Century together with hydrologic conditions, rapid population growth and climate change and variability that affect water security. All these problems interact to create a crisis of a global magnitude.

Integrated water resources management (IWRM) has been identified as an essential component that underpins good and effective water governance (GWP, 2000a). It is a process which enhances the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without

compromising the sustainability of vital ecosystems (GWP, 2000a). Operationally, the IWRM approach involves applying knowledge from various disciplines as well as insights from diverse stakeholders to devise and implement efficient, equitable and sustainable solutions to water and development problems. As such, IWRM is a comprehensive, participatory planning and implementation tool for managing and developing water resources in a way that balances social and economic needs, and that ensures the protection of ecosystems for future generations. Water's many different uses for agriculture, healthy ecosystems, people and livelihoods, demands coordinated action. An IWRM approach is an open, flexible process, bringing together decision-makers across the various sectors that impact on water resources, and bringing all stakeholders to the table to set policy and make sound, balanced decisions in response to specific water challenges faced (GWP, 2000a).

The concept of IWRM is underpinned by the following four main principles (see GWP, 2000):

1. Fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment.
2. Water development and management should be based on a participatory approach, involving users, planners and policy makers at all levels.
3. Women play a central part in the provision, management and safeguarding of water.
4. Water has an economic value in all its competing uses and should be recognised as an economic good, taking into account affordability and equity criteria.

The majority of countries in the Southern African Development Community (SADC) have adopted IWRM as the overall guiding framework for their respective water sectors (Earle et al., 2008). This has been done in the form of legal reform to their water sectors, as in the case of Zimbabwe and South Africa (Kujinga & Manzungu, 2004), or through formal development of IWRM plans and some form of water management strategy or planning document. These documents have in common the IWRM approach, with its emphasis on the governance aspects of water resources, service planning and decision-making. This includes the desire to broaden the decision-making base – through the involvement of water users and other stakeholders in water management issues (GWP, 2000a).

A number of Southern African countries, which include Malawi, Mozambique, Namibia, South Africa, Tanzania and Zimbabwe, embarked on water reform processes in the 1990s aimed at incorporating IWRM principles in their water legislation, plans and policies (Karar & van Koppen, 2002; Kujinga & Manzungu, 2004). Although Botswana embraced the concept of IWRM, it has not yet reformed its water sector as done by the other countries, for example, Zimbabwe and South Africa. The country is still using the 1968 Water Act which, to a great extent, does not include of IWRM principles. As a result, such principles of IWRM as stakeholder participation and the participation of women are not adequately captured by the existing legislation. The country still falls behind in terms of appropriate institutions for water management which afford stakeholders from different sectors an opportunity to take part in water resource management.

Prior to the water sector reforms which started in 2009, three institutions were responsible for water supply in Botswana. These were the Water Utilities Corporation (WUC), Department of Water Affairs (DWA) and District Councils (Kujinga et al., 2014). The WUC was responsible for urban water supply, DWA for major village water supply, and District Councils for small to medium rural village water supply (Swatuk & Kgomotso, 2007). Under the water sector reforms which started in 2009, WUC took over the responsibilities of water supply from the DWA and District Councils. WUC took over the supply of water to the whole of Ngamiland on the 1st April 2013.

1.4.6. Water accounting

Water accounting is defined as a process of increasing knowledge about the interaction between water and human activity with the aim of improving its governance (Molden, 1997; Molden & Sakthivadivel, 1999; Onda, 2012; Peranginangin et al., 2004). The process is done to obtain data on how the availability of water resources is affected by the impacts of physical, monetary and planning factors such as population growth, structure and level of economic activity, urbanisation and increasing standards of living, land cover and land cover changes, (Molden, 1997). The process involves the application tools that link water supply and use with all these factors (Molden & Sakthivadivel, 1999; Onda, 2012; Peranginangin et al., 2004). The process enables the generation of critical data on water availability which enables policy makers and

water resource managers to make informed choices on issues such as water demand management (Molden & Sakthivadivel, 1999). The complete Water Accounting framework comprises stock and use accounts as well as water quality accounts.

Water accounting is an aspect that has the potential of enhancing water governance and, hence, water security. This process is being implemented in only a few Southern African countries which include South Africa and Botswana, but has not been fully adopted in these countries in order to enhance water policy formulation as well as water governance. Botswana has been implementing water accounting since the 1990s, but the process has not yet enhanced water security and good water governance. The country has limited stock accounts (for dams and partial accounts for groundwater) for the period 1990 – 2003. All accounts are physical as monetary accounts do not exist due to data limitations (Department of Environmental Affairs, 2006).

Water accounting for Botswana since the 1990s shows that the stock of surface water has increased in time due to the construction of new dams, but there are significant inter annual and spatial fluctuations (Department of Environmental Affairs, 2006). Groundwater stock accounts are incomplete, but the available figures suggest that abstraction from well fields is much higher than the recharge (Department of Environmental Affairs, 2006). Further investigation is necessary on the recharge of well fields and the abstractable stock of groundwater. There is thus need for more comprehensive data on groundwater stocks since a great number of the population in Botswana depend on groundwater resources for domestic water supply. Accounts on the quality of groundwater resources are also vital for planning and management purposes. The use of accounts show an increase in water use from 140 Mm^3 in 1990 to 170 Mm^3 in 2003 (Department of Environmental Affairs, 2006).

Water accounts have been useful in Botswana, especially for policy makers, in several respects. The accounts for Botswana show the following:

- The trend in water production and consumption that can be used to validate (and when needed, improve) water demand scenarios;

- The most important users and their trends in water consumption. These should be priorities in water management and planning. For example, the rapid growth of water use in the mining sector needs to be addressed;
- The continued high loss rates (or unaccounted water) of water supply, especially from public standpipes which are not metered. This is a waste of scarce resources, and loss reduction need to become a policy priority. Progress can be monitored through the water accounts;
- The different costs of water supply and wastewater treatment;
- The efficiency in water use by the economic sector (in terms of value added and employment) (Department of Environmental Affairs, 2003).

The Botswana Ministry of Minerals, Energy and Water Resources established a water account unit which is a good step in the management of the country's water resources.

1.4.7. Settlement categories of Botswana

The Botswana National Settlement Policy (1998) came up with a settlement framework aimed at guiding and enhancing equitable distribution of investment in infrastructure and economic growth to achieve spatially balanced development across Botswana (Government of Botswana, 1998; Swatuk & Kgomotso, 2007). The objective was to ensure that investments in infrastructure and financial resources were distributed in a way that reflected the different settlement functions, population size, economic potential, level of infrastructure and the role of the service centre to surrounding areas. A hierarchy within which settlements in Botswana are classified has been used since 1998 (Government of Botswana, 1998). The established settlement hierarchy has three 3 tier level. The three levels of the settlements are the Primary, Secondary and Tertiary centers (Government of Botswana, 1998). The criteria for establishing the centers include population size, economic potential, employment generation, availability of natural resources, especially water, to sustain the growth of a settlement; availability of infrastructure and services or the ease with which they can be provided and a settlement's role as a service centre to its hinterland (Government of Botswana, 1998). Though other factors for classifying a settlement are important, the main guiding principle has been that of population, mainly because information for other factors has not been up to date.

Primary centers are settlements with high development potential as they are required to have diversified economies consisting of raw materials for processing into finished products, manufacturing and serving as national market centers. They are also centers with high order infrastructure services and a population of at least 20,000 (Government of Botswana, 1998). These centers are subdivided into Primary I, II and III centers. These sub-categories are based on population size, where Primary centre I has a population of at least 100,000. In most cases these are settlements declared as cities. Primary II centers have a population of between 50,000 to 99,999 and Primary III centers (larger villages) are settlements with a population of 20,000 to 49,999 (Government of Botswana, 1998).

The second category, after the Primary centers, are the Secondary centers. These are described as intermediate centers with a population of 10,000 to 19,999 or settlements with a lower population and a weak economic base but playing a key role as district or sub-district headquarters (Government of Botswana, 1998).

The third settlement tier are the tertiary centers which are settlements with a population range of 250 to 9,999 people (Government of Botswana, 1998). These include Remote Area Dweller (RAD) settlements. They are divided into four sub-categories based on their different functions, their economic potential, population, level of infrastructure and environmental conditions. The following is a description of the different sub-categories of the Tertiary centers:

- Tertiary 1 centers are settlements with a population range of 5,000 to 9,999 people and serving a catchment area with a radius of 30 km.
- Tertiary II centers are settlements with a population range of 1,000 to 4,999 people and serving a catchment area with a 15 km radius
- Tertiary III centers are settlements with a population range of 500 to 999 people and serving a catchment area with a 5 km radius.
- Tertiary IV centers are settlements with a population of 250 – 499 people and serving a catchment area with a 5 km radius.

There are other settlements with a population of less than 250 people which do not fall in any level of the settlement hierarchy. Most of such settlements exist in the form of cattle posts

(Government of Botswana, 1998). These are not entitled to any service delivery since they are not formal settlements. However, some of them have received basic services such as water infrastructure and primary education (Government of Botswana, 1998).

The aim of the Government of Botswana has been to ensure that all its citizens live in recognized settlements where they can access better services and where it is convenient for the government to provide such needed services (Government of Botswana, 1998, 2009). Despite this being the case, informal settlements have continued to sprout. After some years, such settlements usually request to be granted official status.

According to the National Settlement Policy (Government of Botswana, 1998), a settlement may be defined as a village when it fulfils the following criteria: a minimum of 500 people; situated at least 15 km away from the nearest village; has a headman and Village Development Committee (Swatuk & Kgomotso, 2007). There are exceptions where settlements with less than 500 people have been declared gazetted villages and are supplied with water. These are villages in remote areas where the government considers it imperative to supply water in order to uplift the standard of living of such people. Such villages can receive water from the WUC and other services from the district council[4].

1.4.8. Household

Information on the household is important because the household is the basic unit of society, both socially and economically (Roberts, 1991; Vaughan, 1985). The household concept is, however, problematic, both in definitional and analytical terms (Rakodi, 1991). At times the terms *household* and *family* are used interchangeably but these are not synonymous concepts (Yanagisako, 1979). Many writers have pointed out the problems of treating households and families as synonymous and argued for their rigorous separation (Sacchi & Viazzo, 2014; Yanagisako, 1979). The term *household* denotes an institution whose primary feature is co-residence (Bender, 1967). It is assumed that people who live within a single space, share in the tasks of day-to-day servicing of human beings, including consumption and engaging in the reproduction of the next generation, form a household (Bender, 1967). The characteristics of a household are also defined in terms of the "one pot one roof model" (Evans, 1991).

[4] Personal communication with the North West District Council, Water Engineer.

In some literature, the household has been conceptualized in terms of the following analytic dimensions: kinship, the pooling of resources, the shared consumption of meals, living under one roof and/or on the coordination of activities and domestic functions (Beall & Kanji, 1999). Membership of a household is not static but dynamic since some individuals may form part of the household for a temporary period, while others can be regarded as semi-permanent household members (Vanwey, 2003). The definition of a household becomes problematic because all households go through developmental cycles, changing shape and size overtime (Beall & Kanji, 1999).

The usual definition of a household refers to an individual or two or more people who make common provision for food or other essentials for living (Budlender, 2003). The persons may pool together their incomes and, to a greater or lesser extent, have a common budget and they may be related or unrelated (Kobrin, 1976). Household, therefore, refers to the basic unit of co-residence and family which involve normative relationships (Kobrin, 1976). In this study, a household is defined as composed of people who live together (not necessarily permanent), eat together and pool resources (such as water) together (Beall & Kanji, 1999). However, when dealing with the household, one has to guard against ignoring inequalities of power and welfare among household members or assuming that the household can be treated as an undifferentiated optimising unit (Beall & Kanji, 1999).

Individual members of a household are likely to have different interests based on their family status, their gender and their generation. Though members of the household pool resources together, the pooling is often perceived to be inequitable, with women providing more material resources than men while young household members feeling that they have a right to a greater share of their income for personal needs (WHO, 2002). In some quarters, the household is seen as a disguise for male power and female subordination (Lalthapersad-Pillay, 2002). Studies done in Kenya, Malawi and other countries indicate that a larger proportion of women's income tends to be spent on household nutrition and basic welfare than that of men (Lalthapersad-Pillay, 2002). Households of all kinds are thus characterised by power relations that manifest in particular patterns of production, distribution and consumption and it is within this context that most individuals and households make a living or derive their livelihood.

1.5. Study Area

Botswana, formerly Bechuanaland, a British protectorate, is a landlocked country located in Southern Africa and inhabited mainly by the *Batswana* (singular: *Motswana*). The country gained its independence from Britain on 30 September 1966 and came to be called Botswana (Picard, 1987). It is, arguably, one of the African countries with a stable representative democracy and a consistent record of uninterrupted democratic elections. Geographically, Botswana is flat, with up to 70% of its territory being the Kalahari Desert (Omari, 2010). It is bordered by South Africa to the south and southeast, Zambia to the north, Namibia to the west and north, and Zimbabwe to the northeast (Omari, 2010).

Botswana is a mid-sized country and covers an area of 581,730 km^2. With a population of 2,021 million people (according to the 2011 national census), it is one of the most sparsely populated nations in the world (Central Statistics Office, 2011). Fifty-five percent of the population resides in urban areas, while 45% lives in rural areas (Omari, 2010). The country had a Gross Natinoal Income (GNI) per capita of US$14,411 and US$13,102 per year in 2012 and 2013, respectively (UNDP, 2013). This has made Botswana one of the fastest-growing economies in the world (by some estimates, the fourth-largest in Africa). The economy mainly depends on the exploitation of diamonds (Omari, 2010). However, absolute poverty in Botswana affects 20.7% of the households who live below the poverty datum line (Central Statistics Office, 2011).

1.5.1. Ngamiland District

The study was conducted in Ngamiland or North-West District (Figure 1) which is administered by the North West District Council (NWDC). The NWDC is sub-divided into Ngami (administered from Maun Village) and Okavango (administered from Gumare) Sub-district Authorities. Maun Village, with a population of 60,263, according to the 2011 national census, is the district's main administrative center while the district population at last national census (in 2011) was recorded as 158,104 (Central Statistics Office, 2011). The region's main physical feature is the Okavango River system shared between Angola, Botswana and Namibia. On the Botswana side, the river forms a large in-land delta-like feature (actually an alluvial fan) and a World Heritage site, known as the Okavango Delta (McCarthy & Ellery, 1998; McCarthy, Ellery, Rogers, Cairncross, & Eller, 1986). The main commercial and economic activities in the

district include tourism and livestock rearing (Motsholapheko et al., 2010). Households classified as poor (i.e. living below the poverty datum line) in the district constitute 37.6% of the population, while an estimated 15.3% of the adult population is unemployed. HIV and AIDS prevalence in the district is around 20% (Central Statistics Office, 2011).

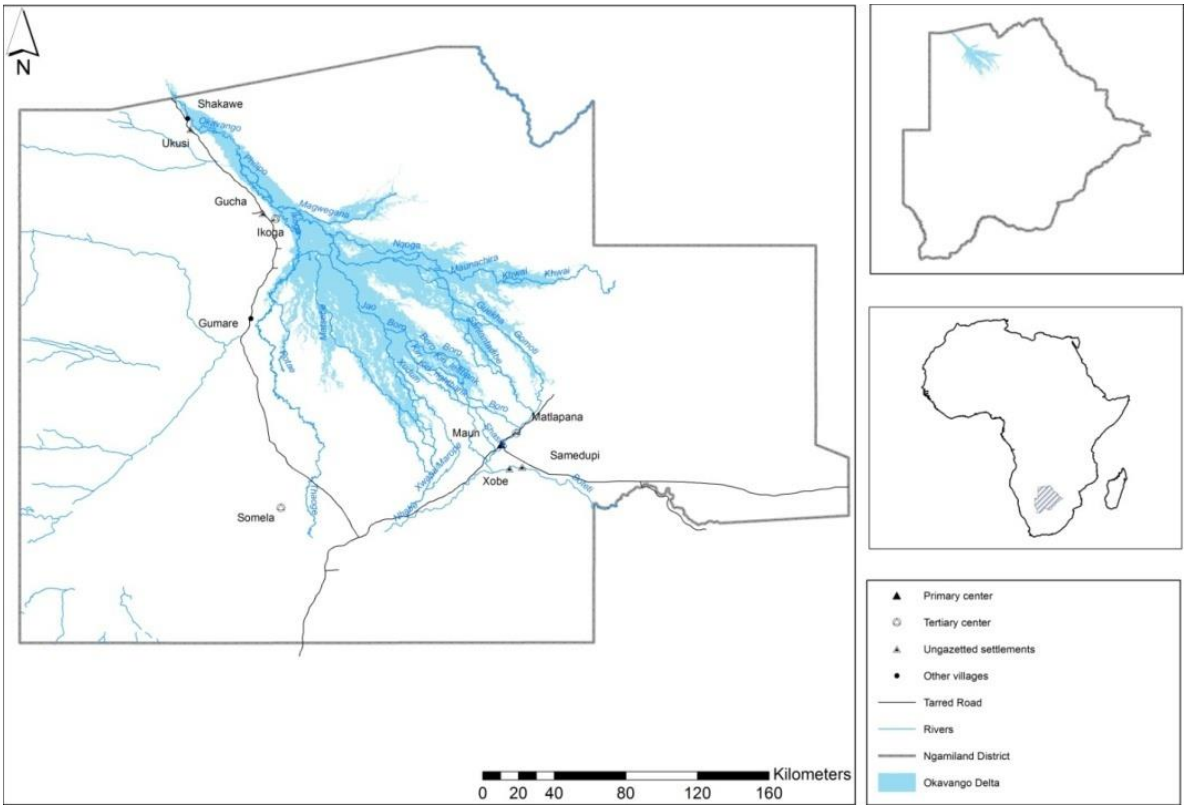

Figure 1: Study sites

The study was undertaken in both gazetted and ungazetted settlements that are found in Ngamiland. Eight purposively sampled settlements, namely, Maun Village (primary center), Matlapana, Somelo and Ikoga (tertiary centers) and Xobe, Samedupi, Gucha and Ukusi (ungazetted settlements), were part of the study (see Figure 1).

1.6. Conceptual Underpinnings

The study was informed by the traditional security concept, (Buzan, 1983; Buzan, Weaver, & de Wilde, 1998; Grey & Sadoff, 2007; GWP, 2000a), human security concept (Alkire, 2003; Barnett, 2001; UNDP, 2006) and the water security concept (See section 1.4). The study was

also informed by the actor-oriented approach (Long, 1988, 1990, 1992; Long & Van der Ploeg, 1994) as well as the concept of governance in general and water governance in particular (Castro, 2007; Helen, 2011; Rogers & Hall, 2003) and the IWRM approach (GWP, 2000a; Stålnacke & Gooch, 2010; P. Van der Zaag, 2005).

1.6.1. The concepts of security and human security

The concept of water security has evolved out of the broader concept of security. Security entails freedom or protection from serious risk and threats to human well-being (Soroos, 1994). A definite aspect about security is that it is associated with the alleviation of threats to treasured values, especially those that, if left unchecked, threaten the survival of a particular referent object, especially human beings (Williams, 2008). In this study, settlements, households and their members are the referent objects who need water security. Security, thus, involves the ability to pursue values that enhance political, social, economic and environmental concerns which impact on human beings (Paris, 2001; Williams, 2008). The study adopted the concept of security and analyzed threats to water security in Ngamiland.

The field of security studies has traditionally been interpreted narrowly in that it has mainly been concerned with the security of territorial states from external aggression, or as protection of national interests in foreign policy or as global security from the threat of nuclear holocaust (Buzan, 1983, 1991; Buzan et al., 1998; Paris, 2001; UNDP, 2006). As a result, security studies have been limited to state, interstate relations and politico-military issues to the exclusion of other sectors such as the society, economy and the environment (Buzan et al., 1998). The narrow definition and focus of traditional studies has left out the legitimate concerns of ordinary people who seek security in their daily lives. The central focus of security has to be the people and, without such a focus on the individual and human dignity, security makes no sense (Williams, 2008). Thus, in their quest for survival, individual human beings seek different forms of security which include political, societal, economic and environmental (Buzan, 1991). The state cannot be the only referent object in need of security as there is also a need to focus on the security of the individual who needs security from threats of diseases, hunger, water shortages, crime, unemployment, political repression and environmental hazards (Levy, 1995; UNDP, 1994). The fact that security has to focus on human beings and the individual, has led to the concept of

human security. The process of ensuring adequate water resources of the right quantity and quality for households for basic needs (i.e. cooking, drinking and sanitation) is one way of ensuring and enhancing human security.

Human security is a process of safeguarding human lives from critical pervasive threats in a way that is consistent with long term human fulfilment (Alkire, 2003). Water insecurity is a pervasive threat which can threaten the core of human lives since water is essential and central to the extent that it has no substitute to human survival (UNDP, 2006). Lack of water resources of good quantity and quality for settlements, households and their members poses an existential threat to human security (Buzan et al., 1998). An existential threat is one that threatens human survival and has to be prevented. In the case of water for household use, an existential threat can be prevented through ensuring water security. The human security concept has two main aspects, that is, firstly safety from chronic threats such as hunger, disease and repression while the second aspect refers to protection from sudden and hurtful disruption in the pattern of daily lives in homes, jobs and communities (Paris, 2001; UNDP, 1994). Threats to water security disrupt daily lives of households and individuals since water is a basic resource to all. Human security is people centered as it is concerned with how people live in a society and how they access critical resources (Buzan et al., 1998).

The current study analyses threats to household water security as well as the structures and institutions that are in place to address these threats. The threats are looked at in terms of direct and indirect threats (Alkire, 2003). The coping and adaptation strategies of individual households are analysed in order to understand how households endeavour to enhance their own water security. Water security problems can have an effect on social and gender relations both at household and community levels. The study also explores how social and gender relations are impacted by water security problems.

For human security to be enhanced and protected from threats such as those associated with household water security, there is need for institutional structures to enhance water security (Alkire, 2003). The study explores the existing water governance structures as well as those proposed under the IWRM approach in order to understand how these enhance water security for households.

1.6.2. The actor-oriented approach

The actor-oriented approach (Long, 1988, 1990, 1992; Long & Van der Ploeg, 1994) was used alongside the concept of security to analyse coping and adaptation strategies to water insecurity by households as well as the gender and social dimensions to water insecurity. The term *actor* is used as a social and cultural construction which refers to individuals, households, groups and formal and informal institutions (including government and quasi government departments) performing actions individually or as cohesive units (Magadlela, 2000). In this study, households as well as their members who include men, women and children are some of the actors involved in ensuring household water availability in the face of any water insecurity. The use of the approach facilitates the identification of different actors as they cope and adapt to water insecurity. The approach also provides insights into gender and other social dimensions of households water insecurity, the actors' interests, objectives and organising strategies (Magadlela, 2000). Concepts of the actor-oriented approach used in this study include actor, lifeworlds, agency and heterogeneity.

The concept of *lifeworld* refers to the actors' view of themselves and their everyday lives (Karin, Nyström, & Dahlberg, 2007). Households can view themselves as either being water secure or insecure. Views of different actors in one particular situation about their water security status may differ. While households can view themselves as water insecure, water supply service providers might hold a different view. The concept of lifeworld also encompasses how different actors view the outside world and interpret new innovations using their conceptual tools acquired in their own world view (Magadlela, 2000). This also refers to how actors organize themselves in coping and adapting to a phenomenon such as water insecurity.

The concept of human agency attributes to the actor(s) the capacity to process social experience and to devise ways of coping with life, even under difficult conditions (Long, 1992). In difficult and seemingly hopeless situations, actors can have the agency to devise strategies or alternative ways of accessing water for domestic purposes. When households as well as their members (that is, both men and women) experience water insecurity, they can devise coping or adaptation strategies that ensure that they have water for domestic use. Households and their members realize that water is essential to sustain their lives and that there is no substitute to the resource

which is needed on a daily basis (Savenije, 2002). As a result, they do not normally become passive actors in the context of water insecurity.

Households facing insecurity can generate heterogeneous forms/strategies of coping and adaptation by using the assets, income and networks they have (Long & Villarreal, 1994). The concept of heterogeneity helps in the analysis of different coping and adaptation strategies adopted in the same or different settlement categories by different households to reduce risk faced during periods of water insecurity. The same water insecurity context can generate differential patterns in terms of coping and adaptation strategies thereby leading to differences in household water availability.

1.6.2. Water governance

The study thus analyses water governance approaches and structures in place in Botswana which enhance both water security and human security. Botswana subscribes to the concept of IWRM. It is imperative to understand how this approach has been operationalised in the country and the impact this has had on household water security. The concept of water governance and the IWRM approach have already been explored earlier in this chapter.

1.7. Paradigm, Methodology and Methods

Overall, this is a cross-sectional comparative study as it analyses water security in different settlement categories of Ngamiland. The study mainly employed the interpretivist and constructivist paradigms. A paradigm is the overlying view of the way the world works; the methodology is the complementary set of guidelines for conducting research within the overlying paradigmatic view of the world. The methods are the specific tools of data collection and analysis the researcher uses to gather information on the world and thereby subsequently build theory or knowledge about that world (Burell & Morgan, 1979). The philosophical assumption of social science researchers can either be from the positivist, constructivist or interpretivist paradigms. This study adopted the interpretivist paradigm. The basic tenets of the interpretivist and constructivist paradigms are presented in this sub-section.

The interpretivist paradigm assumes relativist ontology which posits that there are multiple realities to explain a phenomenon such as water security rather than one causal relationship or theory. In other words, according to interpretivists, reality is socially constructed and not

objectively determined (Husserl, 1965). Furthermore, people make their own sense of social realities (Kelliher, 2005). This paradigm argues that researchers have a greater opportunity of understanding people's perceptions of their activities when they are studied in their social contexts such as households in different settlement categories of Ngamiland (Husserl, 1965). According to interpretive researchers, everyday social practices cannot be disconnected from and studied independently of socially created meaning systems and the language that actors use to describe and make sense of their practices (Angen, 2000). Research findings, for example, of household water security in different settlement categories of Ngamiland, are not produced as established facts but these are offered as interpretations of the studied context (Geertz, 1994). The interpretations of research findings of household water security in Ngamiland are judged based on credibility of the research process, trustworthiness (as a parallel to objectivity) in the research design, and the ways concrete empirical material (observations, interviews, events) are analysed and interpreted (Denzin & Lincoln, 2009). A new understanding or explanation of the phenomena studied is judged based on the richness of descriptions, internal coherence, depth and insightfulness of interpretations and plausibility of results to a reader (Kelliher, 2005).

The interpretivist paradigm relates well with postmodernism which asserts that there is no one truth that describes social phenomena (Chingarande, 2008). This explains the use of different concepts (e.g. security, water security, human security and governance), analytical frameworks (e.g. the actor-oriented approach and integrated water resource management). The core of postmodernism is the doubt that any method or theory, discourses or genre, tradition or novelty, has a universal and general claim as the right or the privileged form of authoritative knowledge. Postmodernism suspects all truth claims of masking and serving particular interests in local, cultural and political struggles (Richardson, 1994). In view of this, what are presented here are multiple and partial truths of people's experiences with household water security in different settlement categories of Ngamiland.

Interpretive researchers use qualitative research methodologies to investigate, interpret and describe social reality (Snape & Spencer, 2003). The research findings in qualitative methodology are usually reported descriptively using words (Denzin & Lincoln, 2005). The province of qualitative research is the world of lived experiences, for this is where individual belief and action intersect with culture. The word *qualitative* implies an emphasis on the qualities

of entities and on processes and meanings that are not experimentally examined or measured in terms of quantity, amount, intensity or frequency (Denzin & Lincoln, 2005; Olsen, 2004). Qualitative researchers stress the socially constructed nature of reality, the intimate relationship between the researcher and what is studied and the situational constraints that shape inquiry. Such researchers emphasize the value-laden nature of inquiry. They seek answers to questions that stress how social experience is created and given meaning (Denzin & Lincoln, 2005).

On the other hand, the constructivist paradigm contends that reality is more in the mind of the knower who constructs reality or interprets it based upon his/her apperceptions (Jonassen, 1991). Knowledge is constructed based on one's previous experiences of mental structures and beliefs which one uses to interpret objects and events (Phillips, 1995). Constructivists do not deny the existence of the external reality, but goes further to argue that each individual constructs his or her own reality through interpreting perceptual experiences of the external world (Jonassen, 1991). There is therefore no single reality or any objective entity that can be described in any objective way; as the real world is a product of the mind that constructs the world (Jonassen, 1991). This paradigm is based on the work of Max Weber and his concept, *verstehen* or empathetic understanding. To attain empathetic understanding, Weber (1978:5) suggests that it is only through sympathetic participation that we can adequately grasp the emotional context in which the action took place. Constructivist researchers also use qualitative methodology and methods in the collection of data as their endeavor to understand the world. Engagement between researchers and respondents in quantitative research is not as deep as in qualitative research (Davis, 1997). The former are described as distant, whereas the latter are described as engaged (Chingarande, 2008). The latter describes the empathy and sympathy that characterizes qualitative research.

There was to some extent, sympathetic participation by the researcher, gained first by understanding the water insecurity situation experienced by households in different settlement categories of Ngamiland. As a result of this, the researcher experienced sympathetic participation, especially when households from different settlement categories of Ngamiland experienced water insecurity between 2012 and 2014. The researcher grieved together with them since he came to realize that water is essential to life and that it has no substitute.

The study further gathered relevant water security related data from secondary sources such as books, articles, local and national government reports, published and unpublished articles and newspaper clippings.

1.7.1. Entry into the field and ethical considerations

Issues of entry into the research field are closely related to ethical considerations. Ethics are defined as norms for conduct that distinguish between acceptable and unacceptable behaviour, that is, what is or is not legitimate to do, or what moral research procedures involve (Newman, 2010). Ethics in research are critical as they outline code of conduct for researchers (Gregory, 2003). The ethical researcher creates a mutually respectful, win-win relationship with the research population. This is a relationship in which subjects are pleased to participate candidly, and the community at large regards the conclusions as constructive. Ethics go beyond conventional processes of managing informants, but also require knowledge about the cultural environment in which the researcher operates.

The study conformed to the requirements of the Botswana Anthropological Research Act of 1967, which requires that any study involving the use of human subjects be registered and permitted by the Government. As a result, a research permit was obtained from the Ministry of Minerals, Energy and Water Resources (see Annex 1). A letter of introduction from the Okavango Research Institute was taken to the NWDC, DWA, WUC and study communities. The letter was given to the officials in charge at the relevant institutions who then introduced the researcher to other officials that the researcher interacted with during the study period. In the study communities, the gatekeepers approached were mainly the *dikgosi* (traditional leaders), ward councillors and village development committees. During the fieldwork, consent was sought from all the respondents. The researcher, together with his assistants, explained the following to all the respondents: a) research purpose and objectives, b) procedures for data collection, c) benefits of the research, d) confidentiality. It was stressed to the respondents that they had the right to withdraw from the study at any point.

1.7.2. Sample design and selection

Ngamiland district was chosen as the case study mainly because all settlement categories in this district experience different degrees of water insecurity. Settlement and household were used as

units of analysis. A total of 554 questionnaires were administered with the assistance of enumerators (see Annex 2 for the copy of the household questionnaire administered). While Social Science research usually considers a sample size of not less than 5% as sufficient for basic statistical analysis (Balnaves and Caputi, 2001), a 30% sample size was adopted in this study (Table 3), using household lists from the 2011 national census by the Central Statistics Office as well as household lists obtained from the District Council and local village leadership. Households in each settlement were listed and each was assigned a number. Over-representation was only done in Gucha village because of the few households in the village. There was no challenge of over- or under representation in the other settlements.

Table 3: Sample size by settlement

Settlement	**Population size (2011)**	**Total number of households listed**	**Number of households sampled**	**Percentage of households sampled**
Maun Village Boyei and Wenela wards	4105	933	295	32%
Gucha	88	20	20	100%
Ikoga	673	153	46	30%
Matlapana	1449	329	99	30%
Samedupi	286	65	20	30%
Somelo	600	133	41	30%
Ukusi	261	60	19	32%
Xobe	260	60	20	33%
Total	7722	1571	554	

A random number generator was used to select households from which respondents were interviewed. Household members who were at least 15 years of age (62% women and 38% men) and knowledgeable about the household's water security situation were interviewed.

A structured household questionnaire, key informant (Annex 3) and focus group discussion (Annex 4) guides were developed. A pilot survey was undertaken in February 2012 which pre-tested the questionnaire, key informant interviews and focus group discussions guides. The pilot survey was done in Sexaxa village and Matswane ward of Maun Village. Households in these areas were randomly sampled. The traditional leaders and village development committee members of these areas were the key informants. The pilot survey helped to improve the data collection instruments. Three enumerators were trained prior to the pre-test survey.

1.7.3. Primary and secondary data collection

The data collection methods are also influenced by the chosen paradigm and research methodology. For this study, data was collected through secondary and primary methods. Secondary data collection included the review of relevant journal articles (both electronic and print), published books, review of government reports (from the Ministry of Minerals, Energy and Water Resources, Ministry of Environment, Ministry of Local Government, Department of Water Affairs, District Councils, Water Utilities Corporation and Statistics Botswana). Secondary sources helped in building concepts used in this study such as that of security as well as in identifying gaps in literature which this study had to focus on in order to make meaningful contribution to knowledge.

The qualitative component of the study entailed the use of different data gathering methods in order to achieve all the objectives of the study. Qualitative research is inherently multi-method in focus (Denzin & Lincoln, 2005). The use of multiple methods reflects an attempt to secure an in-depth understanding of the phenomenon in question (Denzin & Lincoln, 2005). Some of the methods and approaches that fall under qualitative research include case study, participatory inquiry, unstructured interviewing, key informant interviewing, participant observation and focus group discussions. All these methods were adopted during the course of the study since they complemented each other in the quest to understand the dynamics of household water security. The qualitative approach used in this study focused on the collection of quality data, that is, personal feelings, perceptions and experiences. Qualitative researchers are more concerned about issues of richness, texture and feeling of raw data because their inductive approach emphasizes

developing insight and generalizations out of the data collected (Neuman, 2000). The qualitative data collection methods mentioned above, were employed to address all the specific objectives of the study.

Key informant interviews were held with village development committee (VDC) members, ward councilors, traditional leaders and officials of Water Utilities Corporation (WUC), NWDC and Department of Water Affairs (DWA). Ordinary villagers from all the study sites participated in the focus group discussions (FGD) that were organized by the researcher. At least 16 participants participated in each FGD. Gender and age were taken into consideration in the selection of focus group discussion participants. These participants were selected based on their geographical location in the study sites. Issues discussed during the FGDs included the history of water security in each study site, water security challenges being experienced, factors affecting water security, households' coping and adaptation strategies to water insecurity, impact of water insecurity on men, women and children and response by water supply institutions as well as the government's response to water insecurity experienced by households.

Unstructured interviews as well as informal interviews were held with men, women and children of different households. The researcher had the opportunity to visit certain households where such interviews took place. In some instances, a friendship was built and this allowed the researcher to visit the households several times during the course of the study to follow up on issues related to water security challenges, factors which the households viewed as behind water insecurity experienced, coping and adaptation strategies adopted by the households in the context of water insecurity, impact of water security on gender and other social relations and issues related to water governance and water security. Some of the interviews took place at different places which included homesteads and water points. In some instances, the researcher met men, women and children on their way to or from water points carrying containers and would engage them in informal discussions around issues of household water security.

Spending prolonged periods of time and living for three years in Matlapana enabled the researcher to engage in participatory observation as he also experienced water insecurity which other households experienced. This enabled the researcher to have a deeper understanding of

water insecurity and the opportunity to have informal interviews with members from different households in Matlapana and other study sites.

The quantitative approach mainly focused on the collection of quantifiable data in terms of numbers and measures that can be analysed statistically (Neuman, 2000). This included household composition, type of water sources, amount of water used by a household, distance to a water sources and factors affecting water security. In this case, the researcher was concerned about issues of design, measurement and the sample (Neuman, 2000). The study was thus, concerned with validity, that is, whether the study indeed measured that which it intended to measure as well as with reliability, that is, whether the study can be replicated by another researcher in the same context (Allan, 1991). The main quantitative method used was a structured household questionnaire. The structured household questionnaire was administered to a total of 554 households in Maun Village (i.e. Boyei and Wenela wards), Matlapana, Somelo, Ikoga, Ukusi, Gucha, Samedupi and Xobe villages. This was administered to adult members of households from the age of 15 who were knowledgeable about water security issues. Three trained enumerators administered the questionnaire which was translated into *Setswana*.

With regards to Maun Village, it was evident that that all the wards were experiencing water supply challenges, the researcher therefore decided to have an in-depth understanding of these challenges in two wards. Following consultations with officials from the Department Water Affairs and informal interviews held in different wards, the researcher discovered that Boyei was one of the wards worst affected by water supply challenges while Wenela had a relatively better supply of water. The researcher therefore decided to undertake the study in a residential ward worst affected by water supply and one which had a relatively good supply of water.

Water samples were collected from the different households' water sources (i.e. private and public connections, borehole and river points) for micro-biology testing.

As shown above, a triangulation of paradigms, methodologies and methods was used to gain a more holistic view of water security in different settlement categories of Ngamiland. Triangulation reflects the need to secure an in-depth understanding of the phenomenon in

question. When methodologies and methods are combined, there are a number of possible outcomes which may include corroboration, elaboration, complementarity and contradiction where, for example, qualitative data and quantitative findings conflict (Chingarande, 2008). Multi-methodology and multi-method research is an approach employed to address a variety of questions posed in a research investigation. Household water security is an issue which has many facets and it is vital to use both qualitative and quantitative methodologies as well as different data gathering methods. This strategy of using multi-methodology and method added rigor, breadth, complexity, richness and depth to the inquiry.

1.7.4. Field notes

Throughout the study period, there was extensive capturing of field notes which are an integral part of any of ethnographic research (Wolfinger, 2002). During fieldwork, researchers can be part of conversations in unfamiliar places and later withdraw to some more private place to write about these conversations and witnessed events (Chingarande, 2008). This process of writing field notes helped the researcher to understand what he observed and to participate in new ways, to hear with great acuteness and to observe with new lens. Field notes were either written in the presence of participants or jotted down privately after the interviews. If notes were written after the interview, the researcher would either listen attentively or write down in short and later on expand the notes. In some cases, the research assistants who were fluent in both *Setswana* and English would conduct the interview and jot down the notes in the local language and later translate them into English. Conducting interviews in *Setswana* in the presence of the researcher helped him to learn the local language. By the time fieldwork was completed, the researcher could follow through an interview and in some cases join in. However, a number of interviews with officials from DWA, NWDC and WUC were all conducted in English. This allowed the researcher to write down the notes on his own and to probe. Note-taking ensured accuracy in capturing what was said. However, in most social settings, writing down what is taking place as it occurs is a marginalizing activity, making the researcher an outside observer rather than a full ordinary participant (Chingarande, 2008).

In some cases, writing the notes just after the interview was more convenient for the researcher and respondents as the interviews were not intermittently cut to allow the capturing of the major

points. However, in cases where figures were reported, such as in the case of total amount of water supplied to a settlement and the number of improved water sources, it was important to write down this information during the interview but always making sure that the flow of the discussion was not disrupted by note-taking. Note-taking was then done just after the interview when the scene as well as the interaction was still vivid in the mind.

1.7.5. Data analysis

Quantitative data, which is data gathered through the structured household survey questionnaire administration, were analyzed using the Statistical Package for Social Sciences (SPSS) version 21. Variables which included settlement category, settlement, household, income and main sources of water were the independent variables for analysis purposes. The use of SPSS allowed the generation of frequency tables as well as cross-tabulations which allowed data to be analysed with Chi-square. Non-parametric tests in general and Kruskal-Wallis 1-way ANOVA in particular were used in the analysis since the data was not normally distributed. This was used to determine differences between attributes of the non-parametric variables. The Pearson's Chi-square test was used to determine association between variables. Cross-tabulations were used to analyse interrelations between two variables and their interaction.

Qualitative data collection and analysis are not two discrete entities of the research process. Data collection and analysis overlap and the latter occurs throughout the data collection phase and after the data has been collected (Chingarande, 2008). Data analysis involves organizing what the researcher saw, heard and read so that he could make sense of what he learned (Glesne, 1999). A qualitative researcher analyses data by organizing it into categories on the basis of themes, concepts or similar features (Chingarande, 2008; Neuman, 2000). He or she develops new concepts, formulates conceptual definitions and examines the relationships among concepts. The data gathered under this study was thus analyzed using the thematic approach. Thematic analysis is a search for themes that emerge as being important to the description of the phenomenon (Chingarande, 2008; Daly, Kellehear, & Gliksman, 1997). Common themes emerged during fieldwork and these were followed upon and further developed for all the cases. This process involved the identification of themes through careful reading and re-reading of the data (Rice & Ezzy, 1999). It is a form of pattern recognition within the data, where emerging

themes become the categories for analysis (Chingarande, 2008; Rice & Ezzy, 1999). The broad themes which emerged during fieldwork and data analysis phases are household water security challenges in different settlement categories of Ngamiland, factors affecting water security in different settlement categories, coping (short-term) and adaptation (long-term) strategies to water insecurity, gender and other social dimensions of household water insecurity and water governance and household water security in Botswana.

Water samples were analysed in the laboratory at the Okavango Research Institute for three micro-biology parameters, namely faecal coliforms, faecal streptococci and total coliforms. The results were compared against the drinking water specifications for Botswana (Botswana Bureau of Standards, 2009).

1.8. Structure of the Thesis

This thesis has seven chapters, with Chapter One being the introduction, while chapters Two to Six are data chapters and Chapter Seven is the synthesis chapter. Some of the data chapters have been published by different journals and the remaining have been submitted to several journals for peer review. The outline of the different chapters is given below:

Chapter Two: Household water insecurity in different settlement categories of Ngamiland, Botswana

Manuscript submitted to the *Water Journal*. The manuscript highlights the water security challenges experienced by households in different settlement categories of Ngamiland in terms of water supply and quality. There is currently limited academic information on rigorous analysis of water insecurity in different settlement categories of Botswana in general and Ngamiland in particular.

Chapter Three: An analysis of factors contributing to household water security problems and threats in different settlement categories of Ngamiland, Botswana

Published in the *Journal of Physics and Chemistry of the Earth*. The chapter analyses the factors that contribute to household water insecurity in different settlement categories of Ngamiland. The chapter shows that a multiplicity of factors, notably, environmental and climatic, social and

demographic, planning, financial and governance contribute to household water insecurity for households in different settlement categories in Ngamiland.

Chapter Four: Short and long term strategies for household water insecurity in Ngamiland, Botswana

Published in the *Journal of Sustainable Development*. The chapter explores and analyses the different coping and adaptation strategies which households from different settlement categories employ in the face of water insecurity. It is shown that in the face of water insecurity, households are not passive, but devise coping strategies aimed at countering water insecurity.

Chapter Five: Analysis of gender and other social dimensions of household water insecurity in Ngamiland, Botswana

Published in the *Journal of Sustainability and Management*. The analysis in this chapter focuses on gender, that is, women and girls who physically bear the brunt of water insecurity through spending prolonged periods of time fetching water which they carry in containers loaded on their heads. In addition, there are other social dimensions: use of various assets, rainwater harvesting, personal hygiene and the inter-personal politics of fetching water from neighbours' standpipes that are analysed in this chapter. The paper contributes to literature on water security and hopes to influence the development of policies and strategies which enhance water security by governments of developing countries such as Botswana.

Chapter Six: Water governance and household water security in Botswana

Manuscript submitted to the *Journal of Physics and Chemistry of the Earth*. The chapter analyses water resource governance in Botswana and how it impacts on household water security. The goes further in analysing the extent to which Botswana has adopted IWRM principles and the impact that this is having on household water security.

Chapter Seven: A Synthesis

This is the concluding chapter which synthesises the findings of the study as well as the literature reviewed. This chapter also includes the conclusion, policy recommendations and suggestions for future research.

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University of Botswana

Okavango Research Institute (ORI), PhD Thesis Requirements

Summary from the Directorate

A PhD by publication at ORI should comprise of a minimum of four peer reviewed journal articles. Of the papers included in the thesis, **TWO** should have been published or in press in peer reviewed reputable journals. **TWO manuscripts** must have been submitted for publication in peer reviewed journal articles with the approval of the supervisors by the time the thesis is submitted. Manuscripts which have been published or are in press should appear exactly the same way they appear in the journals.

CHAPTER TWO

Household water insecurity in different settlement categories of Ngamiland, Botswana

By

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Abstract: The attainment of water security is a major challenge confronting Botswana, a semi-arid country. This paper analyzes household water security challenges in different settlement categories (i.e. primary centers, tertiary centers and ungazetted villages) of Ngamiland, Botswana. Informed by the concepts of security, water security and human security, the study used a survey of 554 households and qualitative data, collected through key informant interviews, participant observation, focus group discussions and informal interviews. The results of the study established that households across all settlement categories of Ngamiland encounter water insecurity in terms of availability and quality. Gazetted settlement households go for prolonged periods without water supply. Households in ungazetted settlements use water from unprotected sources. The paper concludes that the majority of households in different settlement categories are water insecure and this has negative effects on human security. Botswana has to put in place a water policy which emphasizes the attainment of water security and human security. Strategies and programmes aimed

at enhancing household water security in both gazetted and ungazetted settlements have to be underpinned by scientific research.

Keywords: Botswana, households, Ngamiland, water security, human security, water insecurity, settlements categories

1. Introduction

The availability, accessibility, usage and quality of freshwater resources around the world have been central issues on the international agenda since the late 1970s (Bigas, 2012; Gleick, 2009; Jury & Vaux, 2007; Prud'homme, 2011). One of the objectives of organisations such as the United Nations has been to ensure that the 1.1 billion people, mostly in the developing countries, lacking access to safe and clean water, have potable water available and accessible to them, thereby enhancing water security (Jones, Vardianian, & Hakopian, 2009; UNDP, 2006). There is growing recognition that the urgent and deepening crisis in water stewardship worldwide is a particularly acute problem in developing countries (Rosegrant & Cline, 2003). The problem is being exacerbated by ineffective water governance and lack of financial and material resources to invest in water supply (UNDP, 2006).

An estimated 100 million people in Southern Africa lack access to clean water supply while about 120,000 children die annually as a result of waterborne diseases (Provost, 2014). There has been slow progress in Southern Africa in terms of increasing coverage to safe and clean water supply services through improved water sources since the 1990s (Ainuson, 2010). Out of 15 Southern African countries, Botswana and Seychelles are expected to meet the MDG target which aims at halving the proportion of people without access to safe water through improved sources by 2015 (UN, 2013a). Coverage for improved water sources in Southern African countries is still low, e.g. Malawi, 60%, Tanzania, 60%, Zambia, 61%, (WHO/UNICEF, 2013). Few countries in the region have high coverage of improved water sources, e.g. Botswana, 97%, Seychelles, 100% and South Africa, 95% (WHO/UNICEF, 2013).

However, having improved water sources does not always translate to or guarantee reliable water supply as a number of households with such sources go for prolonged periods of time without

water supply services (WHO/UNICEF, 2013). While 88% of households in Ngamiland, Botswana have improved water sources, 74% of them encounter water supply challenges (Kujinga et al., 2014). In Malawi, where an estimated 50% of the population do not have access to safe and clean water, households in urban and peri-urban areas are forced to buy water from kiosks and neighbors with running water or fetch from unprotected points (Manda, 2009). A decade long economic decline in Zimbabwe (1999 – 2009) reversed the previous gains achieved in enhancing access to clean water in urban and rural areas, a situation which led to 98,000 cases of cholera and 4,000 deaths in 2009 (Manyanhaire & Kamuzungu, 2009). Harare and Bulawayo have been facing chronic water shortages and households have been forced to collect water from unsafe sources (Manzungu & Chioreso, 2012).

The purpose of the paper is to enhance understanding on the extent of household water insecurity in Botswana, in general, and Ngamiland in particular, by: (i) analyising water supply and quality challenges being encountered by households in different settlement categories, (ii) offering policy directions and focus for future research with regards to water security in semi-arid countries such as Botswana.

2. Conceptual framework

The paper is underpinned by the concept of security (Baldwin, 1997; Buzan, 1983, 1991; Buzan et al., 1998; Soroos, 1994), in general, and water security and human security, in particular (Alkire, 2003). Security refers to freedom or protection from serious risks and threats (Buzan, 1983; Soroos, 1994). Achieving water security by ensuring access to clean and safe water is a priority for all developing countries, including those in Africa (World Bank, 2010). Water security reflects a country's ability to guarantee its citizens access to safe water for both domestic and productive purposes in the face of water vulnerability (World Bank, 2010).

Household water insecurity is a pervasive threat to human security as it threatens the core of human lives since water is essential to the extent that it has no substitute to human survival (UNDP, 2006). A state of water insecurity becomes an existential threat to households and their members and this has to be prevented by ensuring that households have access to adequate water of good quality for both domestic and productive purposes. Human security is thus a process of

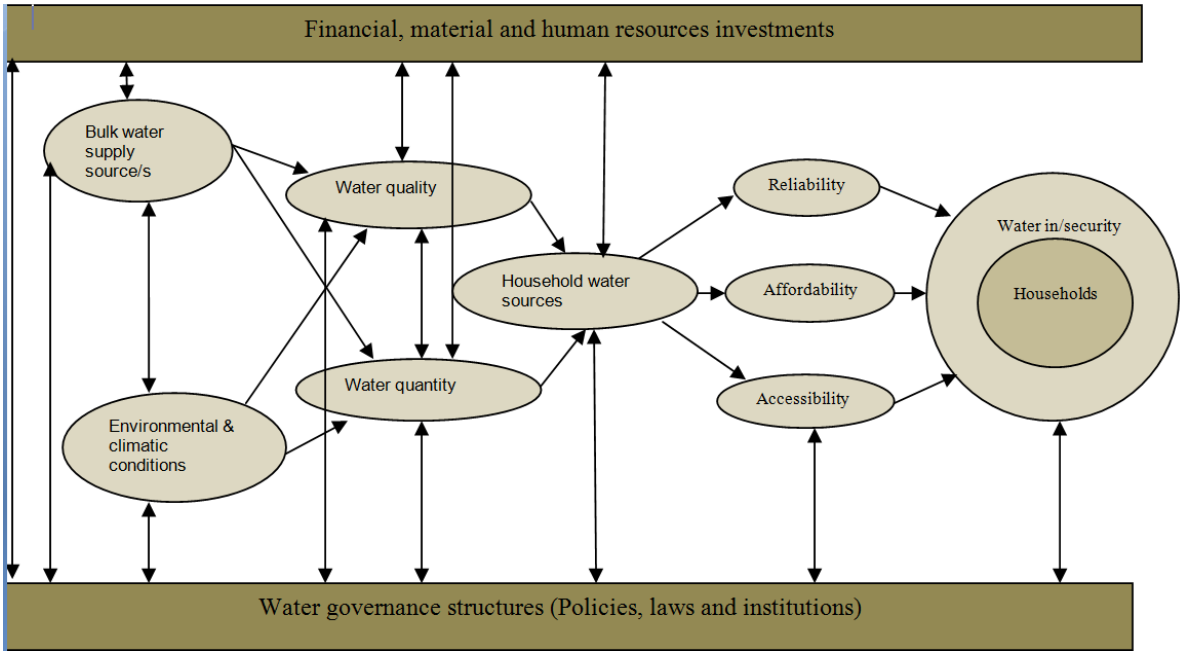
safeguarding human lives from critical pervasive threats, in a way that is consistent with long term human fulfilment (Alkire, 2003). The human security concept has two main aspects, namely, safety from chronic threats such as hunger, disease and repression and protection from sudden and hurtful disruption in the pattern of daily-lives in homes, jobs and communities (Paris, 2001; UNDP, 1994). Human security is people centered as it is concerned with how people live in a society and how they access critical resources such as water of adequate quantity and quality for use at the household level (Buzan et al., 1998).

This article focuses on the provision of water for basic human needs while conscious of the fact that other water uses for agriculture, industry, livelihoods, ecosystem services and the environment are important and closely interlinked. Water security can be defined as access to enough safe water at affordable cost to lead to its users to a clean, healthy and productive life while ensuring that the natural environment is protected and enhanced (GWP, 2000b). Household water security refers to accessibility, reliability and timely availability of sufficient safe water to households to fulfil their basic needs such as drinking, cooking, sanitation and bathing (Ariyabandu, 2001). The household concept denotes an institution of two or more people (not necessarily permanent), whose primary feature is co-residence, eating and pooling resources together as well as involvement in the provision of essential resources required for a living (Beall & Kanji, 1999; UN, 1976). A settlement is a community of households occupying a particular geographical space (Lamprey & Reid, 2004).

Water security is aimed at addressing threats and risks associated with lack or shortage of water for domestic purposes (drinking, cooking, bathing, general cleaning), for food production or food security and energy production (Cook & Bakker, 2012; Grey, 2012; Vanwey, 2003). Risks and threats to water security include unreliable or lack of water supply, surface water contamination, submerging of water supply sources by floods, saline or contaminated groundwater resources and degraded ecosystems (Grey, 2012). The term “security” implies that there is a threshold below which households and individuals become water insecure (Cook & Bakker, 2012). As a result, individuals and households should not live below a certain threshold for water.

Important dimensions of water security, which also have implications on human security, include quantity, quality, reliable access, improved water sources, availability, and affordability (Figure 1) (Ariyabandu, 2001). Water sources for domestic water can be affected by factors such as rainfall, floods and decreased flow (Kujinga et al., 2014). Water supplied to households in a particular settlement is usually abstracted in bulk from particular sources before being distributed. Sustainable management of water supply sources is critical and requires proper governance structures such as policies, laws and institutions. Financial resources are required for investment in infrastructure as well as in operation and maintenance. Human resources are required in different sections of organisations responsible for the supply of water.

Figure 1: Household water security conceptual framework



Source: Improvised framework of the WaterAid water security framework (WaterAid, 2012).

Reliable water supply entails having functioning facilities providing safe water within a reasonable distance from the home, within safe physical reach, being affordable and accessible without exclusion on grounds of race, tribe, religion, disability and gender (United Nations, 2003). An individual needs to have access to at least 20 L of water per day to meet minimum requirements (WHO, 1997; WHO/UNICEF, 2000a). This has to be from a source within 1 km of the user's dwelling (WHO/UNICEF, 2000a). The quality of water should be such that no

significant health risk arises from its use and it should be acceptable to users in appearance, taste and odor (WHO/UNICEF, 2000a). Contaminant levels should not exceed the accepted water quality standards of the region or the country where it is consumed. Water for household use should be free from microbiological contaminants (i.e. pathogenic bacteria, viruses and parasites) and inorganic contaminants such as arsenic, fluoride and nitrate (WHO, 2011).

A minimum capacity of infrastructure and institutions, backed by robust policies and an appropriate legislative framework are needed to ensure basic national water security as well as human security (World Bank, 2010). Water governance affects the quantity and quality of water supplied to households as well as the sources through which the households access water (Tortajada, 2010). Effective water governance ensures water availability, accessibility and affordability, allocation, distribution and operation and maintenance of the water supply system.

3. Materials and Methods

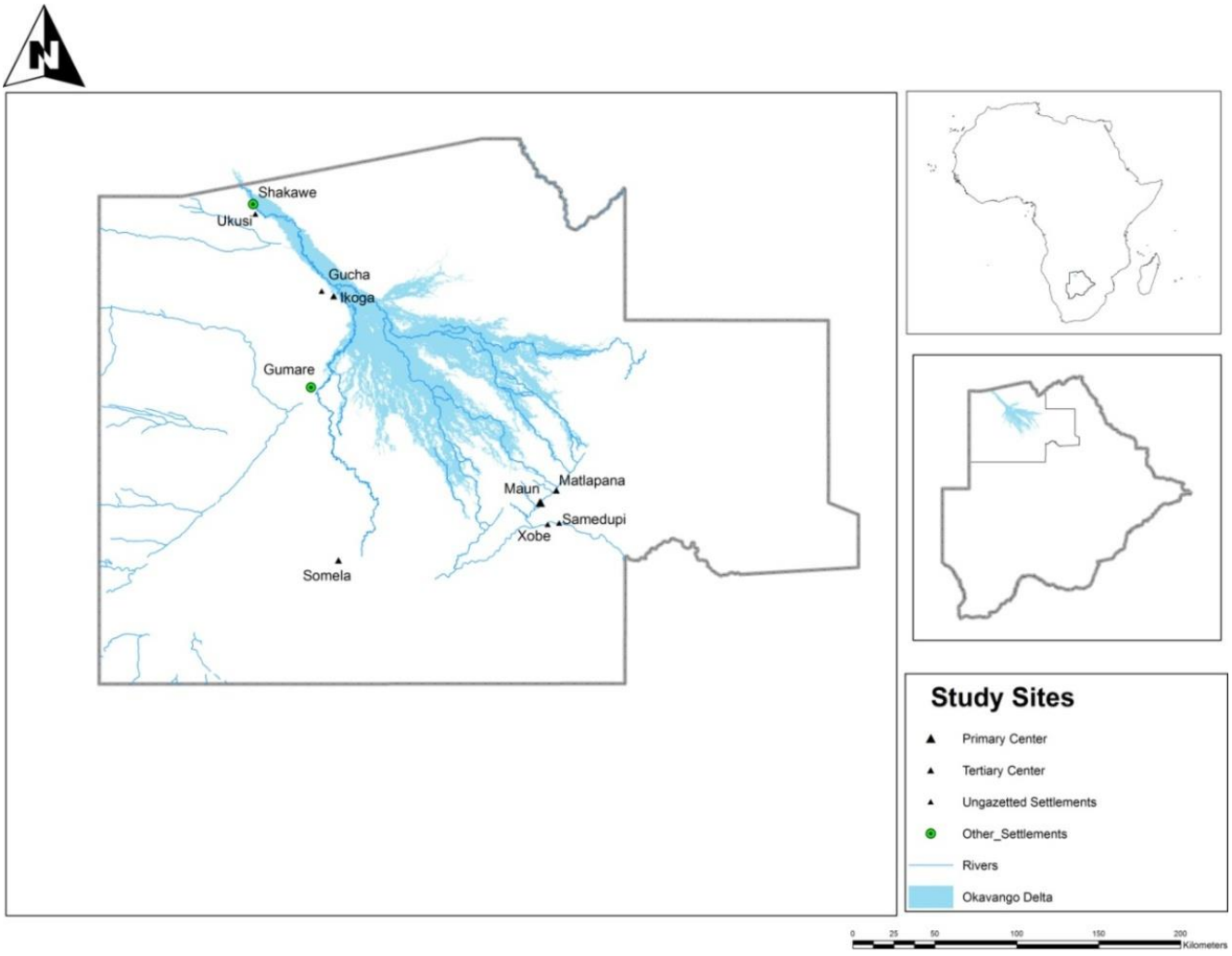
3.1. Study area

The study was undertaken in Botswana's North West District, (also known as Ngamiland) (Figure 2) which, according to the 2011 national census has a population of 158,104 (Central Statistics Office, 2011). The North West District Council (NWDC) (sub-divided into Ngami and Okavango Administrative Authorities) administers the district. The main administrative center of the district is Maun Village which, according to the 2011 national census, has a population of 60,263 (Central Statistics Office, 2011).

Ngamiland receives low and variable rainfall averaging 425 mm per annum, with a coefficient of variation of 35%, which is characteristic of a semi-arid environment. The region's main surface water resources are found in the Okavango River, shared between Angola, Botswana and Namibia. On the Botswana side, the river forms a large in-land delta-like feature (actually an alluvial fan), the Okavango Delta, a world heritage site. Ngamiland experiences high temperatures, up to 40 ^{o}C, as well as frequent droughts and periodic/variable flooding (Mendelsohn et al., 2010; Wolski & Murray-Hudson, 2008). The Delta loses 14,600 Mm^3 of

water per annum as a result of evapo-transpiration against an inflow of 10,000 Mm^3/a and a rainfall of 5,000 Mm^3/a (HOORC, 2007).

Figure 2: Study sites



Two broad settlement categories, that is, gazetted and ungazetted, are found in Botswana (Government of Botswana, 1998). Gazetted settlements are formal settlements entitled to service provision, that is, water supply, education, police, electricity and roads (Government of Botswana, 2009). Three levels, i.e. Primary (sub-divided into I, II and III), Secondary and Tertiary (sub-divided into I, II, III and IV) centers make up gazetted settlements (Government of Botswana, 1998). Primary center I settlements, are cities whose population is at least 100,000. Primary center II settlements have a population range of between 50,000 and 99,999 people while Primary center III settlements, are large villages (e.g. Maun Village) whose population is

between 20,000 and 49,999 (Government of Botswana, 1998). Secondary center settlements (e.g. Gumare) have a population range of 10,000 – 19,999 people (Government of Botswana, 1998). Tertiary center settlements have different population ranges, i.e. Tertiary center I, 5,000 - 9,999; Tertiary center II, 1,000 - 4,999; Tertiary center III, 500 - 999 and Tertiary center V, 250 – 499 (Government of Botswana, 2009). All other Tertiary center settlement categories are found in Ngamiland except Tertiary center I (Government of Botswana, 1998).

Ungazetted settlements are informal and have populations of less than 250 people (Government of Botswana, 1998). These settlements are not entitled to any social service provision.

3.2. Water supply services in Botswana

Three institutions used to be involved in water supply, namely, the Water Utilities Corporation (WUC) which supplied water to towns and cities, the Department of Water Affairs (DWA) supplied water to large villages and District Councils supplied Tertiary centers. Water reforms which commenced in 2009, identified WUC as the most appropriate institution to supply water to all settlements nationally. It (WUC) took over the provision of water to all settlements in Ngamiland on 1 April 2013.

3.3. Data collection methods

The study employed qualitative and quantitative data collection methods. Qualitative data collection methods used included focus group discussions (FGDs) with ordinary community members, key informant (KI) interviews (with ward councilors, traditional leaders, officials from NWDC, DWA and WUC). Participant observation was done in all the sites, including Matlapana where one of the researchers lived for 3 years. This enabled close interaction with households experiencing water insecurity and enhanced a deeper understanding of the phenomenon. Participant observation helped the researcher to engage in informal discussions related to water security issues with people from different households. Information collected through qualitative methods, included household water sources, water supply services and quality challenges encountered by households. Qualitative data was collected between February 2012 and March 2014.

A structured household questionnaire was used to collect quantitative data which included general household characteristics, types of water sources, distance to the sources, quality and water supply challenges. The questionnaire was administered by trained enumerators between May – August 2012.

Water samples were collected from different water sources used by households for micro-biology testing (Table 1). The samples were tested for three parameters, that is, faecal streptococci, faecal coliforms, total coliforms. According to Botswana water quality standards, drinking water should not have any of these in 100 milliliters of water (Botswana Bureau of Standards, 2009).

3.4. Sampling

The study was undertaken in 8 purposively sampled settlements from gazetted and ungazetted villages for the following reasons: (i) Maun Village was sampled by virtue of being the only Primary center settlement in Ngamiland and that it was experiencing water security challenges; (ii) Matlapana was sampled as a Tertiary center settlement whose households experienced water insecurity. One of the authors resided in this village for three years and this allowed for participant observation to be undertaken; (iii) Somelo was sampled in order to understand water supply challenges in a gazetted settlement that does not have surface water resources nearby while its groundwater resources are saline; (iv) Ikoga was sampled to understand water supply challenges in a village receiving its supply from a surface water treatment plant; (v) Ukusi settlement was sampled to analyse water security challenges in an ungazetted settlement which receives water supply services contrary to policy provisions; and (vi) Gucha, Samedupi and Xobe, which are all ungazetted settlements, were sampled to understand and analyse household water security challenges in settlements which do not receive any water supply services.

The settlement and household were the units of analysis of the study. A 30% sample size in the settlements was adopted (Table 1) using population lists obtained from the national census, district council and local village leadership. Households in each settlement were listed during the survey. Each household was assigned a number and a random number generator was used to select households which were interviewed. As a result the selected households were located in

different parts of each settlement. The researcher was able to get maps for the layout of residential properties for Boyei and Wenela only which were used in the sampling of households. In almost all the settlements, households are located close to each other which made it easier for enumerators to locate the sampled households. Trained enumerators administered the structured questionnaire to household members who were aged 15 and above and had knowledge on household water issues. A total of 554 questionnaires were administered.

Table 1: Sample sizes by settlement

Settlement	Settlement category	Population size (2011)	Total number of households listed	Number of households sampled
Maun Village	Primary Center III	4,105[1]	933	295
MatlapanA	Tertiary center II	1,449	329	99
Ikoga	Tertiary center III	673	153	46
Somelo	Tertiary center IV	600	41	41
Gucha	Ungazetted	88	20	20
Samedupi	Ungazetted	286	65	20
Ukusi	Ungazetted	261	60	19
Xobe	Ungazetted	260	60	20
Total		7,722	1571	554

[1] Two wards in Maun Village (Boyei and Wenela) represented the Village.

Key informants were purposively sampled, while FGDs were attended by at least 16 people, both males and females from 15 years old from each settlement. Participants in FGDs were purposively sampled from different areas of each settlement taking into consideration gender and age. At least one FGD was held in each study settlement. Each FGD was facilitated by a trained facilitator fluent in Setswana. The facilitator would ask the questions while someone else took down notes related to the discussion.

Water samples for water quality testing were collected from sources mainly used by households (Table 2). Public standpipes in Ikoga did not have water at the time of sampling. The water samples were mainly collected to give an indicative idea of the microbiological quality of the water.

Table 2: Number of water samples collected from different settlements

Water sources	Settlements and number of samples collected							
	Gucha	**Ikoga**	**Maun Village**	**Matlapana**	**Samedupi**	**Somelo**	**Ukusi**	**Xobe**
Private standpipes	n/a	1	9	2	n/a	2	n/a	n/a
Public standpipes	n/a	0	n/a	2	n/a	2	1	n/a
Borehole	n/a	n/a	n/a	n/a	n/a	2	n/a	n/a
Untreated source	1	1	n/a	2	2	n/a	n/a	2

Data Analysis

Data collected through the structured household questionnaire was analysed using the Statistical Package for Social Sciences (SPSS) version 21. In the analysis, the independent variables were settlement category, household, income and main sources of water. The data was not normally distributed and as a result, non-parametric tests in general and Kruskal-Wallis 1-way ANOVA in particular was used to determine differences between attributes of non-parametric variables. The Pearson's chi-square test was used to determine association between variables, which included income and settlement category; type of household water sources and water shortages or lack of supply and the amount of water used for different activities by households.

Data from FGDs, key informant interviews and participant observation was analysed using the thematic approach. Thus, data were categorized into broad themes of socio-economic background of households, type of water sources used in different settlement categories, household water supply challenges and water insecurity in Primary, Tertiary settlements and ungazetted settlements.

Water samples from different sources and sites were analysed in the laboratory for three micro-biology parameters, including faecal coliforms, faecal streptococci and total coliforms, and the

results were compared against the requirements of drinking water specifications for Botswana (Botswana Bureau of Standards, 2009).

3. Results and Analysis

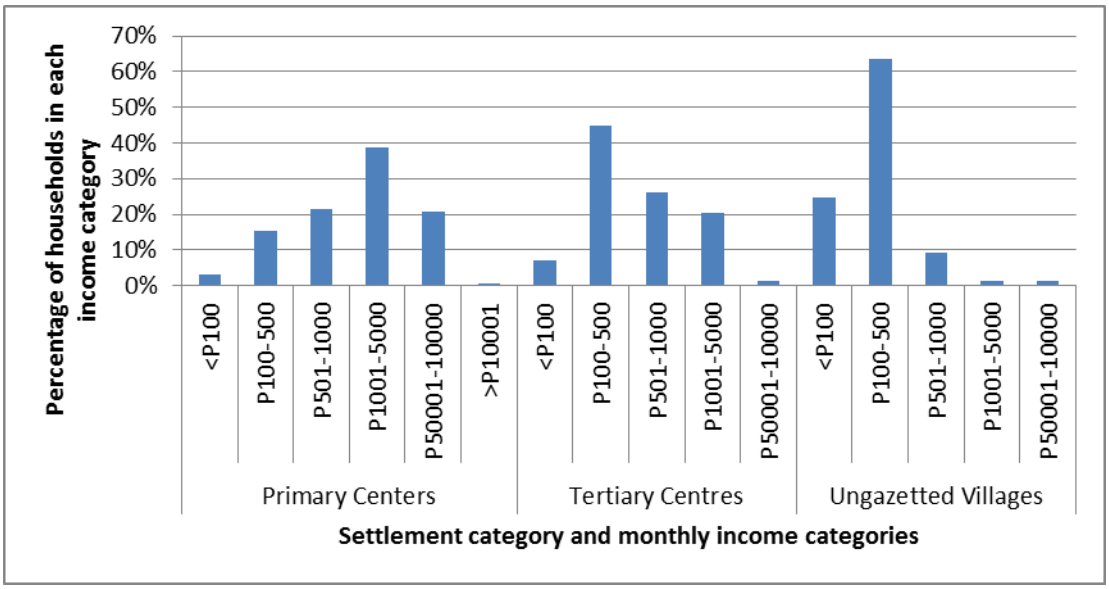
3.5. Socio-economic profiles of the households

The average household size across all the settlements is 5.9 people. There is no significant difference on the average number of household members across the different settlement categories. There are slightly more female-headed households (53%) compared to male-headed households (47%).

There is a statistical association between settlement category and monthly household income (Pearson's chi-square value = 303.0601, degrees of freedom = 35, p=0.000), significant at 5% level. Households with relatively higher incomes, i.e. above BWP1,000[5] are from Maun Village, while households from Tertiary centers, i.e. Ikoga, Matlapana and Somelo, are mainly in the BWP100-500 category, with some in the relatively higher categories of BWP501-1000 and BWP1,001-5,000 (Figure 3) (see also Kujinga et al, 2014). The majority of ungazetted settlement households (63%) (i.e. Gucha, Samedupi, Ukusi and Xobe) are in the BWP100-500 monthly income category, while the remainder (24%) are in the BWP100 and below category (see also Kujinga et al, 2015).

[5] USD1 = BWP8.6, August 2013

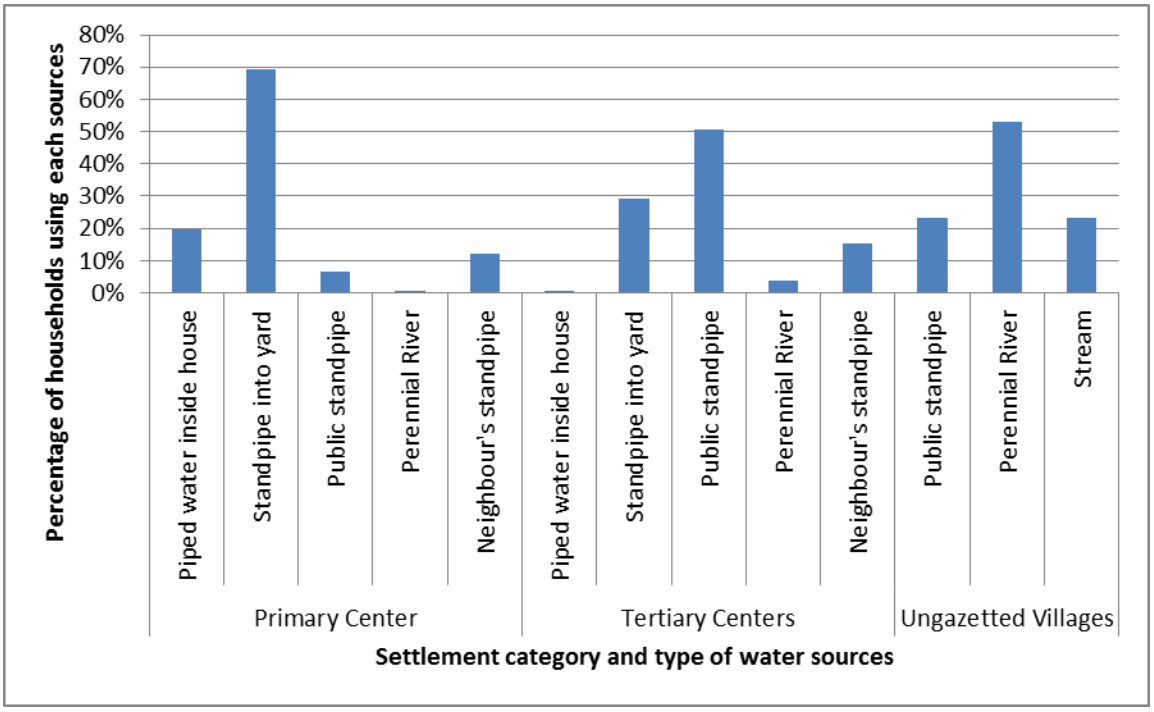
Figure 3: Household monthly income ranges



3.6. Sources of water for households

The government of Botswana's policy over the years, has been to ensure that all households in gazetted settlements have equitable access to safe water for domestic purposes from improved sources within a distance of 400 m (Department of Environmental Affairs, 2008). This has enabled the country to achieve 97% coverage for the population. Data from the study show that 88% of the households have improved domestic water supply sources (Figure 5). Households access water from public standpipes (23.1%), standpipes in yard (46.8%), taps inside the house (10.8%), neighbor's standpipes (7.2%) and untreated sources (12%) (see also Kujinga et al., 2014). There is a statistical association between settlement category and type of main water sources used by households (Pearson's chi-square = 1203.1919, degrees of freedom = 42, p=0.000), significant at 5% level. Households from the Primary center (Maun Village) and Tertiary centers (Ikoga, Matlapana and Somelo) have improved water sources while ungazetted settlements (i.e. Gucha, Samedupi and Xobe) access water from untreated sources such as rivers or streams. Ukusi, an ungazetted settlement, is an exception as the households access water from public standpipes.

Figure 4: Main water sources for households



3.7. Household water supply challenges

Despite the fact that the majority of households from gazetted settlements (i.e. Primary and Tertiary centers) in Ngamiland have improved water sources, they experience frequent water supply shortages which date back to 2000 and in some cases earlier. As a result, household members interviewed highlighted that they are water-insecure due to prolonged periods of time experienced without water supply services. Such a scenario is comparable to the situation in countries such as Ethiopia, Kenya, Malawi and Zimbabwe (Manda, 2009; Manyanhaire & Kamuzungu, 2009; Manzungu & Chioreso, 2012).Water security is viewed by the majority households from different settlement categories as the continuous availability of water of good quality from improved water sources[6]. On the other hand, water insecurity is seen as the lack of availability of water from improved water sources for a period ranging from 1 hour to days, weeks, months or years. In ungazetted settlements, water insecurity is understood as the absence of improved water sources forcing households to fetch water from untreated sources.

[6] This definition was distilled mainly from focus group discussions held across the different settlement categories of Ngamiland.

Between 2005 and 2011, 60% of gazetted settlement households across the different settlement categories faced serious episodes of water shortages. The situation got worse as 74% of gazetted settlement households faced water supply problems from June 2011 to June 2012. Across the gazetted settlements, 32% of the households did not have water supply during the time of the survey.

The study established that during times of water shortages or lack of supply, all households across the different settlement categories use an average of 11.6 L per person per day. This is opposed to an average of 69 L per person per day which households use when water is available. There is a statistical association between water shortages or lack of supply and the amount of water used for different activities by the households across the different settlement categories (Pearson's chi-square value = 182.4355 degrees of freedom = 7, p=0.000), significant at 5%.

All (100%) households across the gazetted settlements indicated that when water is available and accessible from their main sources, they are usually not sure about how long it will be available. As a result, they always fill containers with water and keep them in their houses for use during times of shortage. The households do not have proper means of communicating with service providers about the unavailability of water from their main sources. This is sometimes done by either the ward councilors or the Village Development Committee members.

3.8. Water insecurity in different settlement categories

3.8.1. Water supply to Primary center settlement, Maun Village

Prior to the 1st of April 2013, Maun Village was supplied with water by the DWA which managed 30 boreholes located along the Shashe, Kunyere and Sexaxa floodplains. Out of the 30 boreholes managed by the DWA, 14 were functional by the time the WUC took over water supply to the Village. These functional boreholes yielded 5,760 m^3 of water per day (Kujinga et al., 2014). Sixteen of the boreholes, either broke down or were submerged by floods which took place between 2008 and 2013. The DWA also managed a water treatment plant located in Maun

Village which produced 700 m^3 of water per day instead of the expected 2000 m^3 per day or more mainly due to the size of the electric pump that was used[7]. The functional boreholes and the surface water treatment plant for Maun Village yielded at least 6,460 m^3/day and, when overstretched, this could go up to 7,830 m^3 against a daily demand of 8,319 m^3/day. The situation was complicated by limited storage capacity since only 5,365 m^3 of storage was available for the Village. However, this was increased by 6,000 m^3 at the beginning of 2014 following the completion of a water storage and treatment plant in Maun Village. Though storage increased from 5,365 m^3 to 11,365 m^3, there was no increase in the yield. The increased storage was still below the desired 16,000 m^3 which would have allowed Maun Village to store a two day supply of water. Ten months after the takeover of water supply to Maun Village by WUC, 90% of households felt that nothing much had changed in terms of water supply.

Many households in Maun Village (57%) faced episodes of water supply problems between 2005 and May 2009. During this time, households would experience cut-off in supply that would last for more than 24 hours. As from 2009, the frequency of water shortages started increasing to 3 days or more. A majority of households (73%) identified the period from June 2011 to June 2012 as being the worst period in terms of water supply. In October 2011, the whole of Maun Village experienced acute water shortages, resulting in most residential wards going for more than a month without water supply. Maun Village experienced another acute water shortage which lasted from mid-April to the end of May 2012. Fifty-one percent (51%) of the households experienced water supply shortages within the previous 24 hours of the survey. During the time of the survey, 63% of the households in Maun Village were not receiving water supply services from their main sources.

In March 2011, the Maun Residents Association mobilized residents of Maun Village staged a demonstration and handed a petition to the District Commissioner who was asked to forward it to the Minister of Minerals, Energy and Water Resources. The petition reminded the Minister that access to water is of paramount importance to the achievement of goal 7 of the MDGs, especially the targets on water, and sanitation and eradication of extreme poverty and hunger. It went further to highlight that the supply of adequate drinking water is enshrined in Botswana's Vision

[7] Personal communication with the DWA Water Supplies Manager

2016. The residents reminded the Minister, in the petition that they were being denied access to safe and clean water by the DWA. The petition stated that:

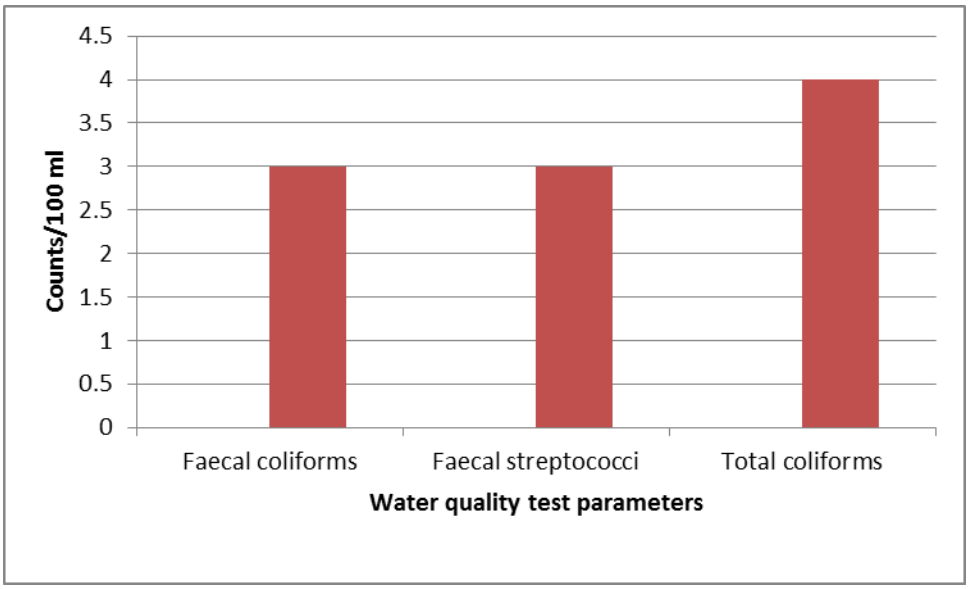
> In contravention of these binding international and national commitments, the DWA in Maun has failed to reliably provide adequate domestic water to residents. For well over ten years now, we have been subjected to deteriorating quality and constant interruptions in the supply of water… Therefore, we kindly seek and pray for the Honorable Minister's presence in Maun in order to appreciate the extent of the problem from the people's perspective. We believe this will provide further impetus for immediate resolution of this problem.

Different media houses captured the water problem in Maun in different issues: *"Maun water woes worsen"* (Voice, 2013); *"Excuses, Excuses, But Maun Still Without Water"* (www.ibotswana.co.bw, 15 May 2012); *Minister reveals plan to address water problems in Maun* (Writer, 2011); *"Maun goes for days without water"* (The Voice, 2011).

Households from Maun Village identified what they thought were factors behind the water shortages that they experience. Among the major factors identified, was an increase in the amount of water each household uses since the majority (90%) of the households have private standpipes and due to changes in lifestyles. Households also identified management challenges on the part of the DWA as a result of old water infrastructure especially pipes and the limited funding from the government for water supply services. However, according to key informants from the DWA and WUC, flooding was a major factor in Maun's water shortages since boreholes located along the floodplains were periodically submerged.

Besides poor water supply for Maun Village, the quality of water supplied is also a major security issue. Water from private standpipes have some microbiological counts, something not allowed under Botswana water quality standards (Figure 5) (Botswana Bureau of Standards, 2009). However, the microbiology counts for the water are relatively low as compared to those of other settlement categories.

Figure 5: Microbiological water quality for Maun Village



However, 56% of households from Maun Village regard the quality of the water from their main sources as being of good quality. Eighty-nine percent (89%) of the households do not treat (e.g. boiling) drinking water from their main sources. Though chemical analysis of the water was not done, sometimes the water from the taps in Wenela and Boyei has a brownish colour[8].

3.8.2. Water security in Tertiary settlements

Sixty-seven percent (67%) of households in Tertiary settlements, that is, Ikoga, Somelo and Matlapana, experienced water supply shortages between 2005 and May 2011. Water shortages in Tertiary settlements worsened as 94% of households did not receive reliable water supply from June 2011 to June 2012. At the time of the survey, 70% of Tertiary center households were not receiving any water supply services. Households from Tertiary settlements always questioned why they have experienced water supply challenges for a long time.

Ikoga, Somelo and Matlapana used to be supplied with water by the NWDC prior to the takeover by WUC. The water source for Matlapana village is a borehole located along the Thamalakane

[8] This was picked up from informal interviews and observations by the researcher.

river channel which was submerged by floods in 2009. By July 2014, Matlapana village households still experienced water shortages. This resulted in 86% of the households accessing untreated water direct from Thamalakane River for household use. Household members at focus group discussions said that there was no motivation for installing private standpipes since they last had a reliable supply of water in 2009.

Somelo village was supplied with water from a borehole situated 40 km away on the channel of Komana River which was submerged by floods in 2009. Efforts to repair the borehole failed. There are no other surface water resources nearby in Somelo. Groundwater sources within the village are saline. The NWDC started hauling water to Somelo on a daily basis since 2009 using a tanker, a practice which the WUC continued to do. However, the hauled water is not sufficient for all the households. The hauled water is offloaded into the village's 20 m^3 storage tank. Household members throng to public and private standpipes with containers from which they usually access water. In most cases, the water gets finished before all the households get an opportunity to fill their containers. Part of the water is accessed by the Somelo Primary School which needs the water to cook food for the children for mid-morning porridge and lunch. The health post in the village also requires water for use.

The boreholes for the supply of water to Matlapana and Somelo villages are located on the channels of Thamalakane and Komana Rivers, respectively. These were installed between 1987 and 2005 when the river channels were not flowing. This enabled pumping of groundwater without encountering any major challenges. The two channels started flowing in 2005 but the floods which occurred in 2009, submerged the boreholes which supplied water to both Matlapana and Somelo, thereby negatively affecting water supply services to the settlements. Households from Matlapana were forced to rely on untreated water from Thamalakane River while those from Somelo had to use saline water as well as the water hauled by a tanker from Maun Village.

Ikoga is supplied with water from the Sepopa treatment plant, located approximately 25 km away. The plant's location along the banks of the Okavango River makes it susceptible to flooding. Between 2009 and 2012, the Sepopa treatment plant was flooded every year.

Households from Ikoga could go for up to three weeks without water mainly due to technical challenges at the Sepopa treatment plant. In February 2014, Ikoga village went for 2 weeks without water supply services.

The water transmission line from Sepopa treatment plant to Ikoga village passes through ungazetted villages such as Gucha which did not receive water supply services. Some of the villagers from ungazetted villages sometimes illegally open sluice valves of the transmission line using vice-grips and access the water. This results in loss of pressure for the water, leading to households experiencing water supply problems. Such a problem can last for up to three days or more. The transmission line also experiences bursting in some sections caused by pressure surges. In a single month, there may be as many as six pipe burst cases which usually takes 6 hours to 3 days to fix.

Ikoga village has 9 public standpipes and only 4 are functional. Prior to the takeover by WUC, 38% of households accessed water from public standpipes while 20% did so from their neighbors' private standpipes who did not have water meters. The owners of such standpipes paid a monthly flat fee of BWP5.75 to the NWDC. In February 2014, the WUC installed water meters on all private standpipes in Ikoga, resulting in the owners refusing to allow their neighbors access to water from their standpipes fearing huge bills.

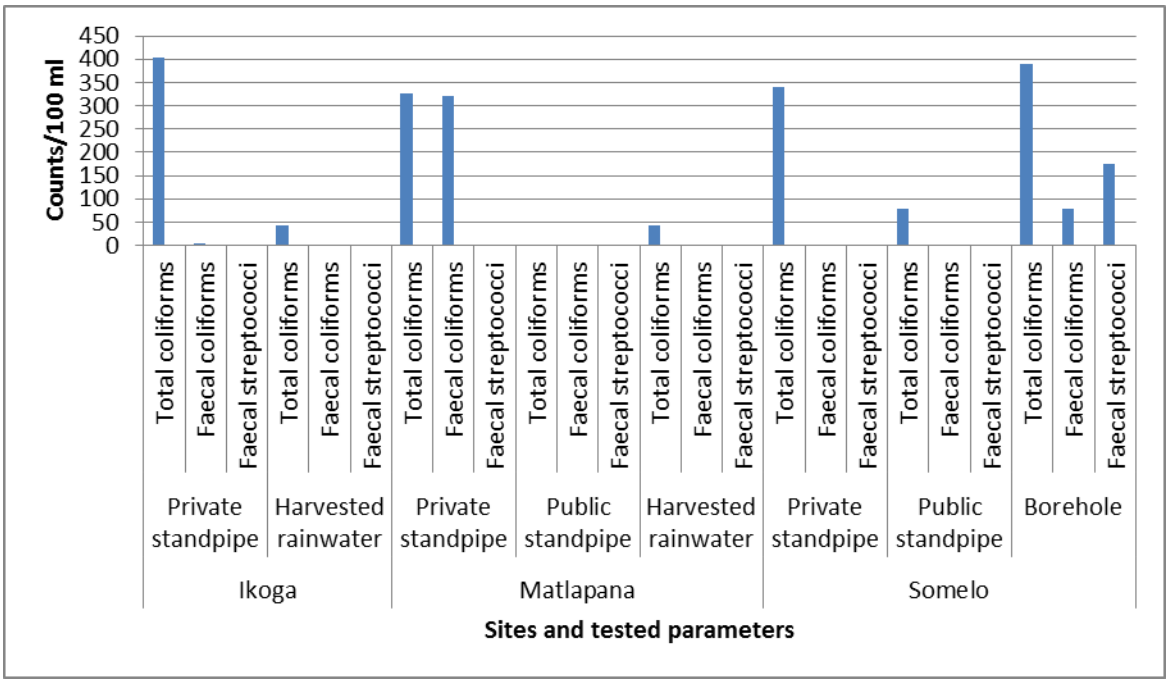
The majority of households from the Tertiary centers (98%) said that WUC does not have the capacity to ensure reliable water availability to their areas. Households from all the Tertiary centers argued that surface water resources were plentiful in the Okavango Delta and the infrastructure was available, but their service provider has no capacity to ensure the availability of water for household use at all times.

3.8.2.1. Water quality in Tertiary settlements

Water from a number of improved sources in Tertiary settlements is not suitable for drinking as microbiological test results showed unacceptable levels of contamination. Water from private standpipes (e.g. in Ikoga, Matlapana and Somelo), public standpipes (e.g. Somelo), borehole (in

Somelo) and harvested rainwater (in Ikoga and Matlapana) (Figure 6) was all found to be unacceptable for drinking purposes.

Figure 6: Water quality in tertiary settlements



Despite this being the case, 66% of Tertiary settlement households said that water from their main water sources was safe for drinking. As a result, no prior treatment is done to the water before consumption by household members.

3.8.3. Water security challenges in ungazetted settlements

Ungazetted settlement households (100%), i.e. Gucha, Samedupi and Xobe, do not receive water supply services. As a result, the households mostly access untreated water (from perennial rivers and seasonal streams) which is of poor quality (Figure 8). Households from Samedupi and Xobe access water directly from the Boteti River, while those from Gucha do so from Kwenookore stream. Xobe and Samedupi are located 15 and 20 km from Maun Village respectively while Gucha is located along a water transmission line from Sepopa treatment plant. Households

(100%) from these settlements feel that it is feasible for them to receive water supply given their proximity to other areas receiving water supply and water transmission lines, respectively.

The households share their water sources with domestic and wild animals. The water makes some of them to contract diarrhea and to develop a skin rash after bathing. Some villagers from Xobe said that:

> We fetch water from this point but our domestic animals also come to drink water from the same point. This is not safe at all as this water definitely has negative effects on our health. But we do not have a choice since this is the only freshwater source that we have which we can use (Xobe, 3 August, 2012).

Though Botswana's policy stipulations do not allow service provision to ungazetted settlements, the Okavango Sub-district Authority supplies water to 20 ungazetted settlements which are located along water transmission lines. Ukusi village is one of the ungazetted settlements which receive such a service. The political leadership in the area lobbied the sub-district authority to supply these settlements since they are already located along water transmission lines. With regards to Ukusi, two 5 m^3 tanks were installed in 2002 and 2003 by the NWDC. The WUC continued to supply water to settlements such as Ukusi. However, households from Ukusi said that on a monthly basis they could go for at least 7 days without water due to problems such as mechanical break downs and electrical power cuts encountered at the Mohembo West treatment plant. In March 2012, the village went for a month without water as a result of a breakdown at the treatment plant. The village had no water supply for the whole of February 2014.

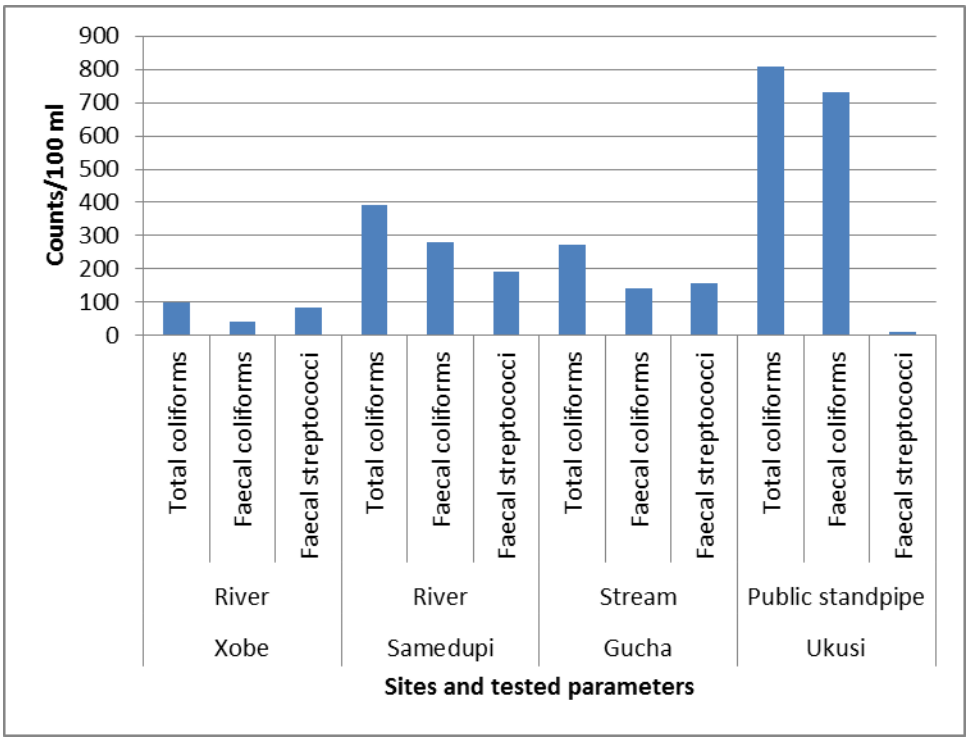
However, not all ungazetted settlements located along water transmission lines are connected to water supply systems. Gucha settlement, located along the transmission line from Sepopa treatment plant does, not receive water supply services. The Sub-district Authority realized that more settlements such as Gucha were mushrooming (due to factors such as need for pastures for livestock and land for cultivation) anticipating water supply services. This forced the sub-district authority to stop connecting more ungazetted settlements to water supply systems. Households

from Gucha fetch water from Kwenookore stream which is 4 km away for most of the households. Water from this stream was described by all the respondents (100%) as being discolored and with a bad taste. Kwenookore stream flows only during the rainy season. As a result, during the period that it flows, the households access what they termed "better" quality water because the flowing water carries away dirt. During winter, when the stream stops flowing, only stagnant and dirty water in some portions of the stream become accessible to households. When the stream is completely dry, the households dig on the stream bed for water.

3.8.3.1. Water quality in ungazetted settlements

Water quality in ungazetted settlements is generally poor due to higher counts of microbes (Figure 7). Seventy-percent (70%) of ungazetted settlement households are aware that they access water which is unsuitable for drinking.

Figure 7: Water quality results for ungazetted settlements



Though the households are aware of the quality of the water that they access for drinking purposes, 87% of ungazetted households do not treat the water in any way to make it safe to

drink. Water quality test results for Ukusi village are surprisingly very poor given the fact that the village's water comes from a treatment plant.

4. Discussion

Developing countries are facing water security challenges as 1.1 billon people lack access to clean water (Hanjra & Qureshi, 2010). Developed countries managed to achieve water security through policy changes, effective water governance, financial investments in water infrastructure, human capacity and technological solutions to water supply (UNDP, 2006). Developing countries have not been able to come up with strategies that enhance water security in the same way that developed countries managed to do (UNDP, 2006). As a result, Africa and eastern Asia are lagging behind in the attainment of MDG goal 7, target 10 which emphasizes on halving the number of people without access to clean water (UN, 2013b).

Data presented in this paper has shown that there is water insecurity, that is, inadequate access to enough safe water for the majority of households in Ngamiland to lead a clean healthy and productive life. Water insecurity experience by households in Ngamiland negatively affects human security (Alkire, 2003). Households in gazetted settlements which have improved water sources do not have access to enough and adequate water of good quality while those from ungazetted villages are not receiving any water supply services, forcing them to access untreated water. The situation in gazetted settlements shows that the presence of improved sources does not always guarantee access to water all times. Thus, the presence of improved sources cannot be used as an effective measure for access to water. Water security, which considers issues of accessibility, availability, quantity, quality, reliability and affordability is a good measure for access to water (GWP, 2000b). Households in Ngamiland are constantly at risk and threats to water shortages as well as poor water quality. Results in this paper on water security in Ngamiland buttress what other studies found out in the same area (Kgomotso & Swatuk, 2006; Kujinga et al., 2014; Mazvimavi & Mmopelwa, 2006). Water security challenges in Ngamiland pose an existential threat to the life of individual household members (Buzan et al., 1998). Human life is under threat globally since 1.6 million people, mainly children, die each year as a result of waterborne diseases while over 4 million are affected by waterborne diseases annually

(UN, 2013b). Cases of devastating impacts of waterborne diseases in Southern Africa include 4,000 deaths as a result of cholera in Zimbabwe between 2008 and 2009 (Mason, 2009).

Water security challenges in areas such as Ngamiland, result in households using less water per capita per day (i.e. 11.6 L) than what is acceptable. The same has been observed in countries such as Zimbabwe, Malawi, Nigeria and Kenya where water security challenges are experienced by households (Adeniji-Oloukoi et al., 2013; Manda, 2009). This is in sharp contrast to countries such as the United States of America where an individual uses 101 L of water per day as opposed to 5 L in developing countries (UNDP, 2006). Households facing water insecurity are unable to use the recommended 20 L of water per person per day (Gleick, 1996; Manzungu & Chioreso, 2012; WHO/UNICEF, 2000b). Failure to provide water supply when infrastructure is present demonstrates management failure on the part of service providers. In the case of Botswana, WUC was supposed to engage in research which delves into the factors that resulted in the DWA and the NWDC in failing to supply water to households in different settlement categories. Research can assist WUC to understand and deal with water supply challenges faced by DWA and NWDC to enable proper water governance and planning.

Botswana's policy of not providing water supply services to ungazetted settlements contributes to water insecurity and human security challenges to households in these settlements. This can be regarded as social exclusion (Atkinson, 1988; Bowring, 2000; Jordan, 1996) which is underpinned by policy since a section of the population is denied water supply services, a public good that is essential for human survival ((Kleiner, 1999; Postel & Ritchter, 2003). This demonstrates shortcomings in a policy which is unable to recognize the existence of ungazetted settlements which play a critical role in Botswana's social, political and economic development (Kgomotso & Swatuk, 2006). There is a need for the country to put in place a water policy that enhances social inclusion by recognizing all settlement categories as requiring priority in the provision of clean water. Such a policy has to make water accessible to all households as highlighted in the Vision 2016 (Presidential Task Force Group, 1997). Such a move will greatly enhance human security in Botswana. Ungazetted settlements are critical for Botswana as livestock farming mainly takes place in these areas (Republic of Botswana, 2003). The country needs to put in place policies which discourage the mushrooming of more ugazettered

settlements. This will allow the government to formalize ungazetted settlements that are currently in existence.

South Africa now recognizes the existence of informal settlements and has embarked on programmes which ensure service delivery in such settlements, including water supply and sanitation. The municipality of the City of Cape Town, set 2008 as the year by which all 220 informal settlements in its area would have access to clean water and sanitation services (Mels et al., 2010). Botswana can give due recognition to ungazetted settlements by recognizing their existence and the need for service delivery, including water supply. Research can be undertaken to come up with viable options on how to supply water to households in these settlements. The approach being adopted for Ukusi village can be replicated in other villages. The Federal Australian government which faces similar challenges of supplying water to remote Aboriginal communities, formulated the Remote Area Essential Services Programme aimed at supplying domestic water to such settlements (Shepherd, 2012). The programme allows the community members in remote communities to operate and maintain their own water supply systems (Shepherd, 2012).

Household water security and human security challenges for gazetted and ungazetted settlements is further worsened by the poor quality of water which households in settlements such as Maun Village, Matlapana, Somelo, Xobe and Samedupi are accessing. Accessing water that is unsuitable for drinking puts individuals at health risk (Bigas, 2012). Poor water quality can be blamed for the outbreak of diarrhea in Ngamiland which claimed the lives of 18 babies in June 2012.

The major water security challenges in developing countries are related to availability, accessibility, quality and reliable supply (GWP, 2000a). This is mainly because water is provided as a social good leading to service providers unable to recover the full cost of supplying the resource (Budds & McGranahan, 2003). Households accessing water from public standpipes in Botswana do not pay for the service while those with private standpipes pay nominal charges. This makes it challenging for the Water Utility to be effective in the supply of water to households. In South Africa, the first monthly block consumption of 6 m^3 is free for each

household (Muller, 2008). It has been argued that water in Sub-Saharan countries which cost an average of USD0.67/m^3, is underpriced as it is below the cost recovery threshold of over USD1.00/m^3 (World Bank, (2010). This underpricing of water results in Sub-Sahara Africa foregoing at least $1.8 billion per year in potential revenue (World Bank, 2010).

In order for developing countries to achieve household water security, there is need for appropriate frameworks (such as the one shown in Figure 1) that include appropriate and effective water polices, governance structures, need for water quality and quantity, improved household water sources, reliability of supply, affordability and accessibility. Water policies for developing countries need to put water security and human security at the center of the development agenda (UNDP, 2006). This entails putting in place proper and appropriate water governance structures as well as laws and institutions that enhance water security. In such an endeavor, financial investment in appropriate infrastructure as well as human resources has to be another priority. Though Botswana managed to do some investments in water infrastructure which allowed all households in gazetted settlements access to improved water sources, more still needs to be done since households still experience water insecurity despite having access to improved water sources (Kujinga et al., 2014; Swatuk & Kgomotso, 2007). Improved sources in gazetted settlements have helped in reducing time taken to fetch water as well as the distance to water sources. However, the governance of water supply, especially ensuring that the improved infrastructure provides water on a reliable and sustainable basis is not effective in developing countries (Cooley et al., 2013). Frameworks for household water security need to be informed by scientific research.

Conclusion

The majority of households in different settlement categories of Ngamiland experience water insecurity despite the fact that households in gazetted settlements have access to improved water sources which do not provide water for domestic use regularly. Water insecurity in Ngamiland mirrors the situation at the global level in general and in developing countries in particular. The majority of developing countries, including Botswana, are unable to guarantee their citizens water security in the context of any vulnerability. Due to water supply problems and lack of water supply in ungazetted settlements, the majority of households are forced to access water

from unprotected sources. Due to water insecurity being experienced by the majority of households in different settlement categories of Ngamiland, human security is being threatened.

Ineffective water governance for gazetted settlements and policy shortcomings related to service provision in ungazetted areas are some of the major factors behind water security challenges in Ngamiland. The government of Botswana has to improve water supply by ensuring that households in gazetted settlements access water from their improved water sources on a sustainable basis in order to enhance water security. There is need for policy changes in order for the state and other actors to provide water supply services to ungazetted settlements.

Scientific research could greatly contribute to water security and human security in developing countries. Further research is required on how the government of Botswana can supply water on a sustainable basis to all settlement categories including those settlements that are categorized as ungazetted. Research has to focus on water governance, especially on ensuring sustainable provision of water to households in the context of vulnerabilities such as floods and limited water resources. Policy on the provision of services, including water supply to ungazetted settlements has to be reconsidered, and informed by scientific research which can recommend various approaches of water supply to such settlements as well as ways to curb their mushrooming.

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CHAPTER THREE

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An analysis of factors contributing to household water security problems and threats in different settlement categories of Ngamiland, Botswana

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ABSTRACT

Globally, water security is negatively affected by factors that include climatic and hydrological conditions, population growth, rural–urban migration, increased per-capita water use, pollution and over-abstraction of groundwater. While Botswana has made strides in providing safe and clean water to its population since independence in 1966, over the years, a combination of factors have contributed to water security problems in different settlement categories of the country (i.e., primary, secondary, tertiary and ungazetted settlements) in general and in the district of Ngamiland in particular. To study water security problems differentiated by settlement category, this study employed quantitative data collection methods (i.e. household structured questionnaires) and qualitative data collection methods (i.e. key informant interviews, observation, focus group discussions and informal interviews), complemented by a review of relevant literature. Water security in all settlements is affected by status of the settlement, i.e. gazetted or ungazetted, climatic and hydrological factors and water governance challenges. In large villages such as Maun, factors threatening water security include population growth, urbanization, management challenges, old water supply and distribution infrastructure, increased demand for individual connections and changing lifestyles. Small gazetted and ungazetted settlements encounter problems related to limited sources of water supply as well as salinity of groundwater resources. In order to enhance water security in different settlement categories, Botswana has to develop a comprehensive water resources management strategy underpinned by integrated water resources management principles aimed at addressing factors contributing to water security problems. The strategy has to be settlement category specific. Large villages have to address factors related to demographic changes, urbanization, management challenges, water supply infrastructure and the introducing of water demand management activities. Households in small villages need provision of water from more sustainable sources while ungazetted settlements need better access to clean water.

1. Introduction

Globally, water security is under severe pressure as a result of a complex of factors that include hydrological conditions, rapid population growth, rural–urban migration, increased per-capita water use, pollution of water resources, over-abstraction of groundwater and climate change and variability (GWP, 2000b; Jones et al., 2009; Vörösmarty et al., 2010; Evengard et al., 2011). Globally, over 1.1 billion people lack access to a safe water supply and 2.6 billion people lack adequate sanitation (WWC, 2000; UNESCO, 2009; Onda et al., 2012). Sub-Saharan Africa has 51% of its population lacking access to a safe supply of water and 41% lacking adequate sanitation (UNDP, 2006b). Water insecurity will continue to afflict Africa for many years to come as it is projected that by 2025, 16% of the population is expected to be subjected to this situation. In the SADC region, 100 million out of the region's estimated population of 260 million do not have access to safe drinking water (Hirji et al., 2002; Mushizhi, 2010). About 155 million people do not have access to adequate sanitation (SADC, 2012).

Global efforts and resolutions to enhance water security by organizations such as the Group of Eight[1] (G8), the World Water Forum and the United Nations have yielded little positive results (Jones et al., 2009). Despite all the efforts which include policies and programmes to improve water supply and sanitation around the world, there are more people lacking safe water and adequate sanitation than there were at the turn of the 21st Century (Falkenmark and Rockstrom, 2004). The most vulnerable are poor countries in Asia and Africa where millions have no access to safe

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[1] Governments of eight of the world's largest economies (excluding two of the actual eight largest economies by nominal GDP: China, 2nd, and Brazil, 7th). These include France, Germany, Italy, Japan, the United Kingdom, the United States, Canada and Russia A major focus of the G8 since 2009 has been the global supply of food.

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and centrally supplied water (Ngaira, 2007). As a result, the majority are forced to use polluted surface or groundwater (Jones et al., 2009). Such a development failure cannot be directly attributed to the physical scarcity of water, but rather to poor governance (GWP, 2000b; Abrams, 2001; Gleick et al., 2002; Falkenmark and Rockstrom, 2004; Ngaira, 2007).

In the pursuit of water security by a government or society, the issue of water equity needs to be seriously taken into consideration. Equity entails social justice or fairness; it is an ethical concept, grounded in principles of distributive justice (Hatfield et al., 1978). Water equity can be achieved through a water pricing structure and allocation and distribution policies. In order to achieve water equity, many African countries use the increasing block tariff system which allows large volume consumers to pay more, while low volume consumers who are often the poor pay affordable rates (Banerjee, 2010). The other strategy used by governments in Africa is to ensure that all households have access to water through communal standpipes and they do not have to pay for the water consumed. This approach is used in Botswana, Namibia and Zimbabwe (Manzungu and Chioreso, 2012). Only those households which opt to have private connections are required to pay a nominal monthly fee (Arntzen et al., 2000).

Botswana is equally threatened by water security problems as a result of climatic and hydrological factors, urbanization, inadequate/imperfect water policies (which compromise on equity), water governance challenges, demographic changes, over-abstraction of ground water resources and deteriorating water quality (Swatuk and Kgomotso, 2007; Mazvimavi and Mmopelwa, 2006). Some communities throughout Botswana encounter problems of inadequate water supply or poor water quality (Swatuk and Kgomotso, 2007). These problems are happening at the backdrop of changes in the climate as evidenced by high temperatures, periodic droughts and flooding in basins which include the Okavango basin (Mendelsohn et al., 2010). These events negatively affect the availability, quantity and quality of freshwater resources which households can access. Groundwater resources in Botswana are also limited both in quantity and quality and are unevenly distributed (CAR, 2005). Governance challenges include an old legislative framework, financial constraints and institutional operations (Swatuk and Kgomotso, 2007).

The purpose of the paper is to analyze factors affecting water security in different settlement categories of Ngamiland district in Botswana. This paper argues that several natural and man-made factors affect water security in Ngamiland district. Legislative and policy frameworks for water in Botswana do not adequately spell out the importance of water security nor mechanisms for enhancing it, thus not providing an effective framework for water management that enhances water security as well as overall human security.

1.1. Conceptual framework

This paper is underpinned by the concepts of water security (Webb and Iskandarani, 1998; GWP, 2000b; Grey and Sadoff, 2007; Vörösmarty et al., 2010; Zeitoun, 2011; Cook and Bakker, 2012; Lautze and Manthrithilake, 2012), human security (UNDP, 1994; Alkire, 2003; Gasper, 2005; UNDP, 2006a; Matlary, 2008) and equity (Trawick, 2001; Phansalkar, 2007). Human security is defined as the process of protecting individuals from all types of threats that could harm the person (UNDP, 1994; Alkire, 2003; Gasper, 2005). Water shortages and water quality problems threaten the individual since water is essential for human survival for which there is no substitute (Savenije, 2002). Water security refers to access to enough safe water at affordable cost to lead a clean, healthy and productive life while ensuring that the natural environment is protected and enhanced (GWP, 2000b). Water equity can be defined as the absence of systematic disparities in water allocation and distribution between social groups who have different levels of underlying social advantage/disadvantage, that is, different positions in a social hierarchy (Trawick, 2001; Phansalkar, 2007). Policies which pursue water equity endeavor to ensure that all social groups have access to a fair allocation or distribution of water to meet their daily needs.

Water security and human security concepts are derived from the general concept of security (Buzan, 1983; Soroos, 1994; Levy, 1995; Ayoob, 1998; Buzan et al., 1998). Broadly, security entails freedom or protection from serious risk and threats to human well-being (Soroos, 1994). The concept was previously confined to the area of foreign policy and international studies where it referred to the defense of a sovereign state from violent attacks from other states or from terrorists or some revolutionary groups within their borders (Buzan, 1983; Ayoob, 1998; Buzan et al., 1998). This view of security was strengthened during the Cold War by viewing the safety and certainty of the state as the major concern (Buzan 1983; Barnett, 2001). The security of the state was achieved through the maximization of military power (Buzan, 1983; Weaver, 1996). This was a narrow interpretation and conception of the concept as other forms of security which include human and environmental security were seen as peripheral and therefore excluded from the security discourse (UNDP, 1994).

The end of the Cold War in the early 1990s, saw the broadening of the concept of security to include the legitimate concerns of ordinary people as they seek security in their daily lives. Focus was shifted from considering the state as being the referent object for security to other sectors that affect human beings. This was on the basis that there is need to give attention to ordinary people's quest in seeking security from threats of diseases, hunger, water shortages, crime, unemployment, political repression and environmental hazards (UNDP, 1994; Levy, 1995). This type of protection is termed human security which is a process of safeguarding the vital core of all human lives from critical pervasive threats, in a way that is consistent with long term human fulfillment (Alkire, 2003). Human security is people centered as it is concerned about how people live in a society and how they access critical resources (Buzan et al., 1998). Water is such a critical resource because water shortages and poor quality water threaten human lives. Hence the importance of water security.

In this study, water security is concerned with water availability and accessibility as well as with its adequate quality, its affordability, distribution and usage (Zerah, 2000; Savenije and van der Zaag, 2002; Machiwa, 2003; Ribot and Peluso, 2003; Trevett et al., 2005; UNEP, 2010). The paper analyses factors affecting the aforementioned dimensions of household water security as a fundamental dimension of human security that sustains life (Alkire, 2003). Water insecurity enhances the transmission of a wide range of diseases (i.e. diarrheal diseases, skin and eye diseases, worm infestations). It also worsens malnutrition as it leads to stunting, lower school and work productivity, impaired cognitive functioning and learning capacity.

Water is essential to the extent that it has no substitute to human survival (UNDP, 2006a). Lack of access to water resources of good quantity and quality poses an existential threat to households and their individual members (Buzan et al., 1998). An existential threat is one that threatens human survival. Lack of clean water, especially for drinking, cooking and sanitation purposes is one such that calls for immediate action by the state and its apparatus to adopt certain strategies to address the threat (Weaver, 1996).

Factors which affect household water security can either be manmade, that is, as a result of inappropriate policies and programmes or can emanate from the forces of nature. Both manmade and natural factors can interact to affect water security. When these factors interact and threaten households and their

individual members they pose an existential threat if not well addressed through effective policies, strategies and plans (Buzan et al., 1998).

2. Materials and methods

2.1. Study area

The study was undertaken in Ngamiland district located in the north-west part of Botswana (Fig. 1). The district is divided into two sub-districts, Maun Administration Authority (serviced from Maun) and Okavango Administration Authority (serviced from Gumare) (GoB, 2009). The district covers an area of 109,130 km^2 and according to the 2011 census, has a population of 158,104 (CSO, 2011). The main commercial and economic activities in the district include tourism, livestock rearing and crop production, especially flood recession farming (Motsholapheko et al., 2010). Households classified as poor in the district are 49.7% while an estimated 30.7% of the adult population is unemployed (MFDP, 2007). HIV and AIDS prevalence rate in the district is 27.3% (MFDP, 2007).

Two broad settlement categories, that is, gazetted and ungazetted settlements are recognized in Botswana (GoB, 2009). Gazetted settlements are formally recognized by the central government and receive vital services such as water supply, roads, schools health and police. Ungazetted settlements are not formally recognized settlements and are not entitled to vital service provision. The criteria for establishing a gazetted settlement include population size, economic potential, employment generation, natural resources availability such as water for sustaining the settlement, availability of infrastructure and social and economic services provided by the settlement (GoB, 1998). The main guiding principle for establishing a settlement is population size mainly because information for other criteria is often not up to date. There are three levels which make up gazetted settlements and these are the Primary, Secondary and Tertiary centers (GoB, 1998).

Primary centers are settlements with high development potential, a sound industrial base which enable them to serve as national market centers, high order infrastructure services and a population of at least 20,000 (GoB, 1998). These centers are subdivided into Primary I, II and III. Primary centers I have a population of at least 100,000 (e.g. Gaborone). These are settlements declared as cities.

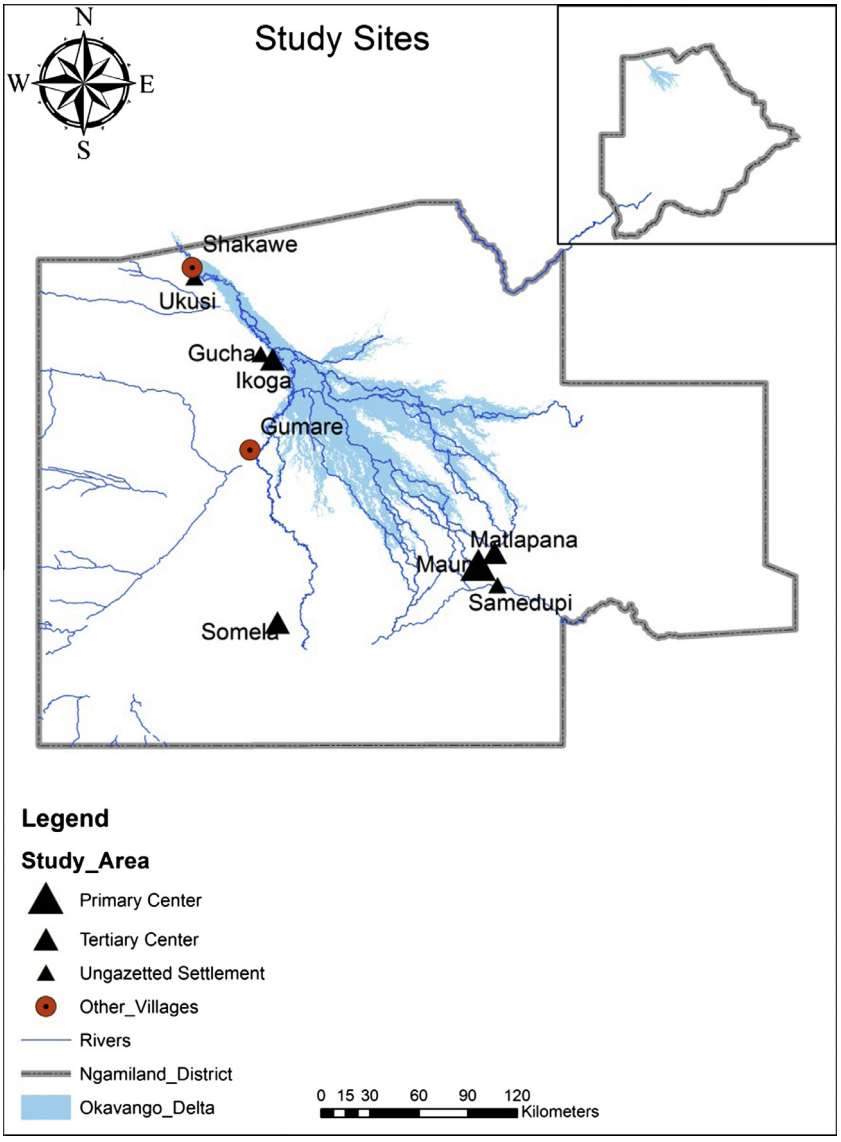

Fig. 1. Map of Ngamiland showing the study areas.

Primary centers II have a population of between 50,000 and 99,999 and Primary centers III have a population of 20,000 to 49,999. Ngamiland District has only one Primary Centre III, Maun Village.

Secondary Centers are intermediate centers with a population of 10,000–19,999 or settlements with a lower population and a weak economic base but playing a key role as district or sub-district headquarters. Gumare is the only settlement in Ngamiland which falls within this category (see Fig. 1).

Tertiary centers are settlements with a population ranging from 250 to 9999 people. They are divided into four sub-categories, that is, I–IV. Sub-categories II–IV are the ones found in Ngamiland. These are:

1. Tertiary centre I settlements have a population range of 5000–9999 people and serve a catchment area with a radius of 30 km.
2. Tertiary centre II settlements have a population range of 1000–4999 people and serve a catchment area with 15 km radius
3. Tertiary centre III settlements have a population range of 500–999 people and serve a catchment area with 5 km radius.
4. Tertiary centre IV settlements have a population of 250–499 people and serve a catchment area with 5 km radius.

Ungazetted settlements have a population of less than 250 and these mainly exist in the form of cattle posts. The majority of the settlements (87%) in Ngamiland district fall within this category (GoB, 2003).

Until the 31st of March 2013, three institutions were responsible for domestic water supply in Botswana, that is, Water Utilities Corporation (WUC), Department of Water Affairs (DWA) and District Councils (Swatuk and Kgomotso, 2007). WUC was responsible for urban water supply, DWA for major village water supply and District Councils for small/medium rural village water supply. With regards to rural village water supply, water services are only provided to officially recognized villages. This institutional set up led to challenges in coordinating these institutions and this led to a blurred clarity and misunderstanding about responsibilities, and to duplication of services. The framework was found to be inappropriate and was resulting in poor coordination among institutions engaged in the same sector (GoB, 2009). In 2009, Botswana started the implementation of water sector reforms under which it was decided that there is need for one water supply institution as this will help in streamlining the cumbersome arrangement that existed then. The WUC was identified as the most appropriate institution which could supply water to cities, towns and all large and small villages. The WUC took over the supply of water to Ngamiland on the 1st of April 2013.

This study involves 8 settlements from the primary, tertiary and ungazetted settlement categories. These are Maun (Primary centre), Matlapana, Somelo and Ikoga (tertiary centers) and Xobe, Samedupi, Gucha and Ukusi (ungazetted settlements) (see Fig. 1). The settlements were sampled from the upper and lower parts of the north-western and south-eastern parts of the district with the aim to obtain a broad overview of factors affecting water security in the district.

Most of the data presented in this article was collected between February 2012 and January 2013.

2.2. Data collection methods

The study employed qualitative and quantitative methodologies. Methodology refers to the rationale and the philosophical assumptions that underlie a particular study (Hidden, 1998). The philosophical assumption of researchers can either be from the constructivism or interpretivism (i.e. qualitative) and positivist (quantitative) paradigms. The constructivist paradigm, contends that in order to understand the truth which is constructed in the minds of individuals, one has to employ qualitative data collection methods (Charmaz, 2006). The same view is held by interpretivists who argue that the world is interpreted through the mind; e.g., classificatory schemes of species. Thus, the social world cannot be described without investigating how people use language and symbols to construct social practices; i.e., understand their experience. The social world becomes the creation of the purposeful actions of conscious agents; and no social explanation is complete unless it could adequately describe the role of meanings in human actions (Hopeful, 1997). The study thus made use of the constructivists and interpretivists data collection methods which include key informant interviews, focus group discussions informal interviews, observations and participant observations.

Key informant interviews were held with officials from the NWDC and DWA (i.e. station manager, hydrologists, water supply and distribution managers, water quality expert, water engineers and those responsible for operating and maintaining treatment plants), community leaders, such as councilors and traditional leaders, school heads, teachers and health professionals. Focus group discussions were conducted with ordinary community members in order to get information on their opinions and perceptions about factors affecting water security in their settlements. Informal interviews were held with ordinary members from different households across all the study sites. Participant observation was used as one of the authors lived in Matlapana and spent some time in all the study sites. This enabled him to experience, observe and understand the extent of water security problems as well as the factors behind them. Close interaction with households in the study sites enabled further exploration of the observed issues.

The positivist paradigm on the other hand, mainly focuses on the collection quantifiable data in terms of numbers and measures that can be analyzed statistically. Quantitative research methodology is more concerned about issues of design, measurement and sample because its deductive approach emphasizes detailed planning prior to data collection and analysis (McMillan and Schumacher, 2009). The quantitative approach focused on the collection of data using a structured household questionnaire. Information collected includes general household characteristics, extent of water security problems in each particular settlement and factors behind these problems.

More information was also collected through the review of reports and other necessary documents from the NWDC and the DWA.

2.3. Sampling

A combination of sampling techniques for the sites was adopted. These included purposive sampling, used for selecting Maun, the only primary centre and Matlapana which was selected for the purposes of closer analysis of issues since one of the researcher is based in this settlement. Convenient sampling was used to sample, Somelo, Ikoga and ungazetted villages which include Gucha, Xobe and Ukusi. Settlements in different categories were sampled so as to understand and compare factors affecting water security. Travelling costs and accessibility to the settlements necessitated the use of convenient sampling.

The study uses the household as the unit of analysis. A total of 554 questionnaires were administered in 8 settlements. Household members involved in fetching of water who are between 15 and 60 years and above were interviewed. A 30% sample size in most of the settlements was adopted (see Table 1) using lists obtained from the national census, district council and local village leader-

Table 1
Sample sizes by settlement.

Settlement	Population size (2011)	Total number of households listed	Number of households sampled
Maun[a]	4105	933	295
Gucha	88	20	20
Ikoga	673	153	46
Matlapana	1449	329	99
Samedupi	286	65	20
Somelo	600	136	41
Ukusi	261	60	19
Xobe	260	60	20
Total	7722	1571	554

[a] Two wards in Maun (Boyei and Wenela) were sampled to represent the village. These were selected on the basis of the water supply situation. Boyei faces acute water shortage while Wenela experiences a relatively good reliable supply of water. Population shown in this table relates to these two wards.

ship. The population of each settlement was verified using census data for 2011. Simple random sampling was adopted in the selection of the households. Households in each settlement were listed and each household was assigned a number. A random number generator was used to select households which were interviewed.

Key informants were purposively sampled. Focus group discussions (FGD) were attended by at least 16 participants from each settlement. Each group consisted of males and females from 11 years old and above. One FGD was held in each study site.

2.4. Analysis of the data

Quantitative data presented in this article was analyzed using the statistical package for social sciences (SPSS). Cross tabulations were done in order to analyze the issues by settlement and the results are presented in the form of graphs. Qualitative data was analyzed using the thematic approach.

3. Results and analysis

3.1. Socio-economic backgrounds of households

Households in different settlement categories have different monthly incomes. Household income has a bearing on equitable access to water as households with more disposable income can afford private connections and to pay for consumption while those with less disposable income cannot do the same. There is a significant difference ($p = 0.00$) in terms of income across the settlement categories studied. Significant different differences ($p = 0.00$) mainly exist between all the other settlements (i.e. Gucha, Ikoga, Samedupi, Somelo, Ukusi and Xobe) and Maun and Matlapana. There is significant no difference between ungazetted settlements and tertiary villages (i.e. Ikoga and Somelo). Households in Maun fall within the BWP501–BWP1000 (21%), BWP1001–BWP5000 (39%) and BWP5001–BWP10,000 (21%) monthly income brackets. In Matlapana, the households fall mainly into three income brackets, that is, 26% are in the BWP100 – 500, 33% in the BWP501 – 1000 and 37% BWP1000 – 5000 monthly income brackets. Households in Somelo (68%), Samedupi (78%), Xobe (80%) and Ikoga (60%) are mainly in the BWP100–BWP500 (USD11–USD57)[2] per month income brackets. Gucha (60%) households are in the BWP100 and less monthly income bracket. In Maun, where the households have relatively higher incomes than other study sites, most of the households have private water connections.

[2] USD1 is equivalent to BWP8.7.

3.2. Access to water by households in different settlement

Households (88%) in the gazetted settlements mostly use improved domestic water supply sources (Fig. 2). The government has tried to ensure equitable access to water to all households in gazetted settlements. Water is accessed from communal water points (23.1%), taps on yard (46.8%), taps inside the house (10.8%) and neighbor's taps (7.2%). Households (12%) using unprotected water sources are mainly from ungazetted villages. Maun Village households mostly have either piped water inside their houses or on the plot outside the house (Fig. 2). Tertiary settlements households generally access water from communal taps.

Some households from Somelo and Ikoga access water from their neighbors' taps. Households in Somelo allow their neighbors to fetch water from their private sources mainly because they do not pay high monthly charges (pegged at BWP1.50 for up to 5 m^3). In Ikoga and Matlapana households which do not have meters or malfunctioning ones, are charged a flat monthly rate of BWP4.50.

3.3. Extent of water security problems

Though there has been progress towards ensuring that households in different settlement categories in Ngamiland access clean water through improved sources, households across all the settlements experience water security problems for periods ranging from one day to more than 12 months. Households were asked the question, "Within the last 12 months (preceding the survey), has your household been having water readily available from your main source?" (Fig. 3). Across all the study sites, 74% of the households experienced episodes of water security problems. Almost all the gazetted settlements faced water security problems within one year preceding the survey (Fig. 3).

Households across all gazetted settlements perceive water security as the continuous and uninterrupted availability and accessibility of good quality water from main source. Water security problems is defined as unavailability of water from main source for a period ranging from 8 h to years and availability of bad quality water, i.e. discolored, bad smell or with some sediments. Water security problems experienced in Maun are captured in a petition presented to the Minister of Minerals, Energy and Water Resources in October 2011 by the residents after they staged a demonstration over poor water supply and quality. Part of the petition read:

> "...the Department of Water Affairs in Maun has failed to reliably provide adequate domestic water to the residents. For over ten years now, we have been subjected to deteriorating quality and constant interruptions in the supply of water. Many wards in the village continue to experience chronic shortages, going for days, weeks and months without water. This has had negative effects on household welfare, delivery of essential social services such as medical care and business. The situation has deepened poverty, reduced the standard and quality of living, aggravated sanitation and eroded the credibility and image of Maun as a tourism transit port and destination area".

As indicated from the above quotation, water security problems are usually blamed on the service providers which include the DWA and the NRDC.

Thirty-one percent (31%) of households did not have water from their main sources during the time of the survey. Fifty-one percent (51%) of the households from Maun experienced acute water shortages within 24 h preceding the survey. All (100%) of the households from Matlapana and Somelo (100%) had not had water from their main sources since sometime in 2009.

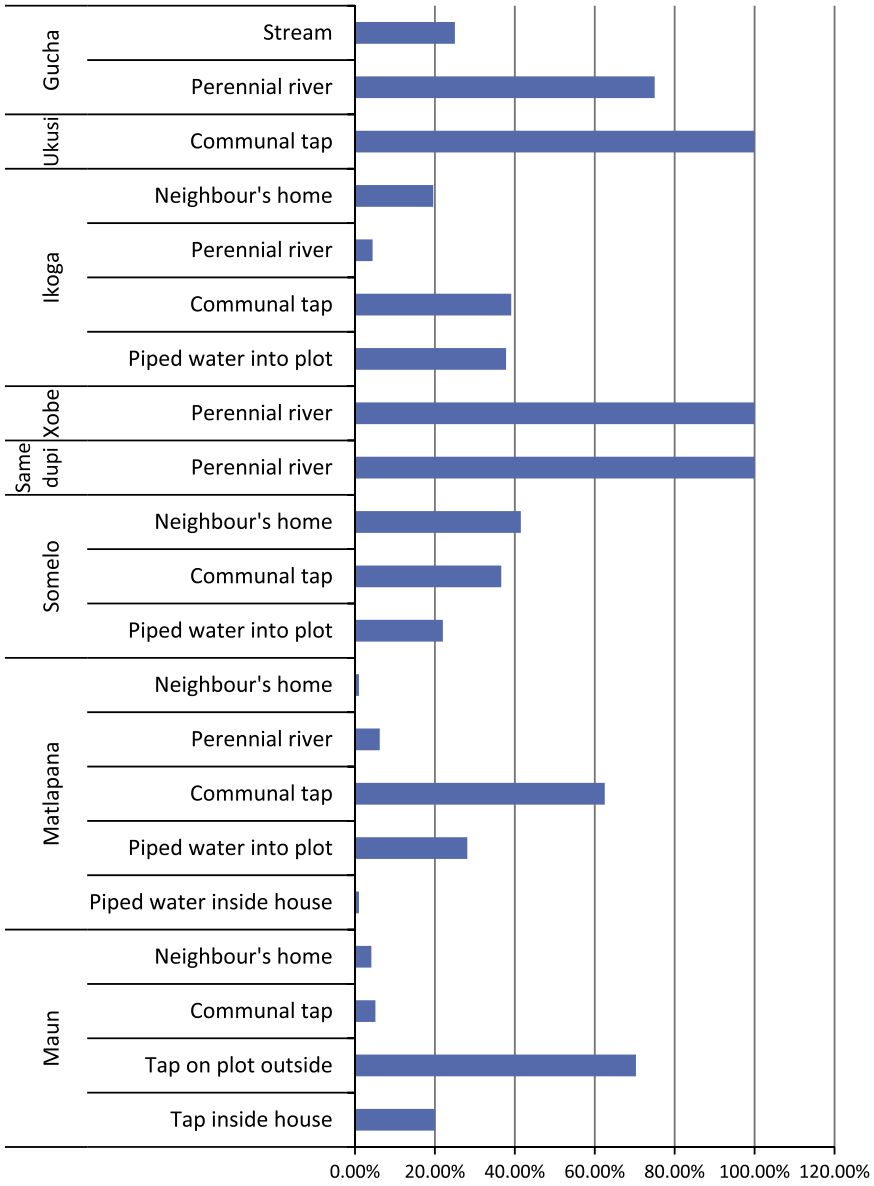

Fig. 2. Main water source for households by settlement category.

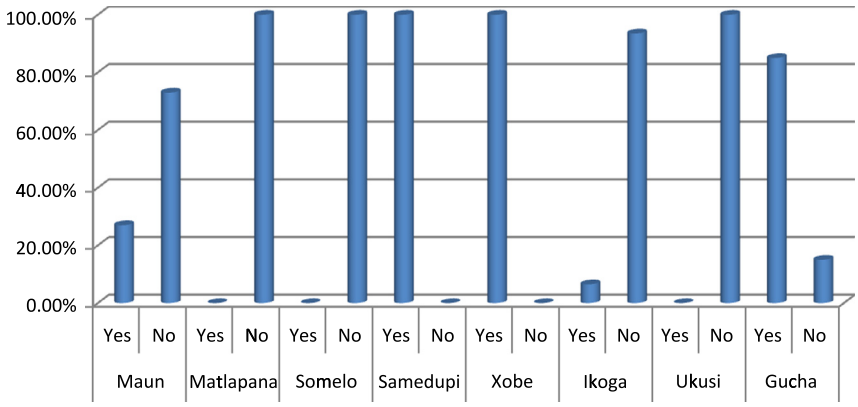

Fig. 3. Households experience of water security problems by settlement within the previous 12 months from date of survey.

All (100%) of the households in ungazetted settlements such as Gucha, Samedupi and Xobe face water security problems since they access water direct from perennial rivers and seasonal streams. They highlighted that though they had no problems related to accessing water from unprotected sources, they are concerned with the poor quality of the water. They share water

sources with domestic and wild animals. The water makes some of them to contract diarrhea, and to develop a skin rash after bathing.

Water security problems in gazetted settlements worsened within the last 10 years. More than half (57%) of the households in Maun, Matlapana, Somelo, Ikoga and Ukusi highlighted that between 2006 and May/June 2011 they were facing water security problems. These were not very serious initially, but escalated as from 2009. Since then, water security has been a serious problem, especially for Maun, Matlapana and Somelo.

3.4. Factors affecting water security in Ngamiland

Factors behind water security problems in different settlement categories in Ngamiland are presented below. These are status of settlement, climate and hydrology, technical, socio-economic, governance and infrastructural factors.

3.4.1. Status of settlement

The status of a settlement in Botswana determines whether it receives services such as water supply or not. There is generally lack of equity to water supply between gazetted and ungazetted villages in the country. A gazetted settlement is entitled to services such as water, health, education and police. Water service is provided ahead of any other services. According to the current settlement classification based on the 2001 census, Ngamiland has more ungazetted settlements than gazetted ones as highlighted in Table 2.

The majority of ungazetted settlements are not receiving critical services such as water supply due to their status. Such villages include Xobe, Samedupi and Gucha. For water supply, the households rely on unprotected sources. Xobe and Samedupi households get water from the Thamalakane/Boteti Rivers while those from Gucha get water from a nearby stream and settlement which gets piped water. When the rivers and streams are dry, households fetch water from hand dug wells within the riverbed.

However, there are ungazetted settlements which receive potable water supply. Most of them fall under the Okavango Administration Authority and are situated in areas where transmission lines from treatments plants such as Sepopa and Mohembo West pass through. The sub-district made a political decision in the 1990s to connect some of the settlements to transmission lines and let households access water from communal points. This political decision was spearheaded by ward councilors. As of August 2012, the Okavango Administration Authority was supplying 30 ungazetted settlements with water, including Ukusi. Other ungazetted settlements which are along the same transmission line, such as Gucha, are not receiving the water. The NWDC indicated to households in Gucha that council no longer connects ungazetted villages as doing so encourages the mushrooming of such settlements. Gucha was established in 1998 along the Gumare-Shakawe road by about 20 households which hoped that by moving closer to the road they would get water supply services from the NWDC. The water transmission line started function in 2001 and Gucha village has not been connected to this line.

Large villages such as Maun and settlements which include Matlapana, Somelo and Ikoga are provided with water either from underground sources or surface water treatment plants or both. Other infrastructure provided are energy source for pumping and critical components, transmission mains, distribution networks and storage tanks (Hagos 1994). Within each gazetted settlement, residents are not supposed to walk more than 400 m one way to a water source (Swatuk and Kgomotso 2007). Communal taps are supposed to be ideally placed within a distance of 250 m. However, most of the communal taps in Matlapana and Maun (i.e. Boyei and Wenela) are not functional. Matlapana village has 2 taps out of 10 that are functional while none are working in Maun. Residents of Maun said, DWA officials removed critical components of the communal taps while in some instances these were damaged by residents. According to DWA officials, the management of communal taps is problematic as they breakdown regularly. In order to encourage residents to have their own private water connections, the DWA stopped repairing the communal water points.

Table 2
Ngamiland District settlements, 2001. *Source*: Ngamiland District Settlement Strategy, Plantec Africa (2003).

Population size	Number of settlements	% of settlements
<249	478	86.8
250–999	61	11
1000–4999	10	1.8
5000–9999	1	0.2
>10,000	1	0.2

3.5. Climatic and hydrological factors

Surface water resources in Ngamiland are limited as the region is generally dry with an annual rainfall ranging from 450 mm to 600 mm. Rainfall in the district is erratic and variable while evapo-transpiration rates are very high (in excess of 1700 mm/year). Surface water resources in the district are found in the Okavango Delta, although most (96%) of the Delta's water evaporates. The Delta receives an inflow of 10,000 Mm^3/a and rainfall of 5000 Mm^3/a while the evapo-transpiration rate is 14,600 Mm^3/a (HOORC, 2007). A combination of porous geology, highly permeable Kalahari sands and overall low rainfall, negatively affect surface water resources. The district experiences long-term variability in terms of both rainfall and flow of the channels of the Delta as in some cases these maybe normal or above normal or below normal in other years. Households which draw water straight from river channels highlighted that variability in the flow of the rivers affect them negatively when the flow is low. This leaves them without any reliable sources of water.

The situation in Ngamiland is made worse by the fact that the area has no suitable sites for dam construction for storing water for domestic purposes. Damming in the Delta is not feasible since the area is fragile and flat. Damming would have negative impacts on the ecosystems of the Okavango Delta. Moreover, most of the water from a dam would evaporate. Settlements in the district therefore depend on groundwater sources for domestic purposes. But, officials from the DWA Hydrology section said that groundwater resources in the district are limited and are mostly saline. A settlement such as Somelo does not have any surface water resources nearby while available groundwater resources are saline.

Extreme events such as floods have had a negative impact on water sources which supply Maun, Matlapana, Somelo and Ikoga. The DWA in Maun has a total of 30 boreholes all located on the channels of different streams of the Okavango Delta, namely Thamalakane, Shashe and Kunyere (see Table 3). More than half of the boreholes are non-functional because they were submerged by floods or contaminated by the river water between 2009 and 2011.

The DWA managed the Wenela treatment plant and four potable treatments plants which supply water to Maun Village. The Wenela treatment plant has a daily output of 2208 m^3 while the four potable treatment plants have a combined daily output of 1920 m^3. However, the four potable treatment plants can only give an output of 440 m^3/day due to capacity constraints. The water treatment plants are able to supply water to Maun Village as long as the surface water from Thamalakane River is available. The functioning boreholes and the treatment plants give a combined supply of 7830 m^3/day. This falls short of 12,722 m^3/day the village is supposed to get if all the developed water sources are functioning.

Table 3
DWA borehole information. *Source*: Department of Water Affairs, Maun.

Location	Number of boreholes	Expected yield (m^3/day)	No. of non-functional boreholes	Number of functional boreholes	Yield of functional boreholes (m^3/day)
Kunyere	7	1746	3	4	2880
Sexaxa	5	1638	3	2	744
Shashe	18	5210	10	8	2136
Total	30	8594	16	14	5760

The NWDC was responsible for 4 boreholes located along the channel of Thamalakane River which supply Matlapana and surrounding villages. These boreholes have been submerged and contaminated by fecal matter since 2009 because of floods. The council also operated a borehole located at Komana which is supposed to supply Somelo settlement which is 40 km away. The borehole got submerged and damaged by floods in 2009 and has not been repaired.

In the north-west part of the district, some settlements are supplied with water from surface water treatment plants in Sepopa and Mohembo East and West. Ikoga village is supplied with water from Sepopa water treatment plant which has a capacity of 400 m^3/day. The location of the treatment plant on the banks of the Okavango River makes it prone to flooding. Since 2009, the treatment plant site has experienced flooding during the rainy season resulting in stoppage of all the functions of the plant. Flooding also causes blockage of sand filters at the beginning and end of floods. In 2011, the treatment plant was flooded for three weeks and electric motors and filtration panels were damaged interrupting the supply of water to Ikoga village and other settlements.

Some of the water sources for Maun Village have been found to contain arsenic (As) as well. Arsenic is a global problem which negatively affects millions of individuals (WHO, 1993). High levels of arsenic in water can cause gastrointestinal discomfort, vomiting, coma, death, leucopenia, skin cancer and other internal cancers (WHO, 1993; Gorby, 1994). According to the DWA three boreholes along Thamalakane River had to be decommissioned between 2000 and 2010 as a result of high levels of As. The water quality lab in Maun has no capacity to test water for the presence of heavy metals like As. A study conducted in the Okavango Delta showed that its surface water is slightly enriched in As when compared to global values for stream waters (Huntsman-Mapila et al., 2006). Arsenic concentrations in the surface water analyzed range from 1.1 to 3.1 μg/L,[3] with an average concentration and precision of 2.3 μg/L, respectively (Huntsman-Mapila et al., 2006). These As concentrations of surface water in the Okavango Delta exceed the global average value of 1.7 μg/L for dissolved As in stream water (Martin and Whitefeile, 1983). Some of the boreholes whose water was analyzed were found to have values exceeding 10 μg/L which exceeds WHO values for As (Huntsman-Mapila et al., 2006).

Climatic and hydrological factors greatly contribute to water security problems in different settlement categories in Ngamiland. High variability of rainfall, limited surface water resources, high evaporation rates and salinity of groundwater resources combine to contribute to water security problems, while flooding of boreholes and treatment plants is another challenge that most gazetted settlements encounter.

3.5.1. Technical factors

Several technical factors contribute to water security problems experienced by different settlement categories in Ngamiland. Settlements affected by technical factors include Maun, Matlapana, Ikoga and Ukusi.

[3] Micrograms per liter.

3.5.1.1. Operation and maintenance of boreholes.

There is a heavy reliance on human labor for the operation and maintenance of boreholes which all run on diesel. The boreholes have to be refueled on a daily basis. There have been problems of diesel being diverted for personal use resulting in boreholes stopping. When a particular borehole stops running, this is only discovered when personnel visit the site for refueling the next day. During the flooding season, it is difficult for the personnel to reach some of the boreholes. There have not been efforts to ensure that the boreholes run on more reliable sources of power such as electricity and also place them on raised platforms so that they are not affected by floods. Telemetry can also be considered on the operation of the boreholes if they are to be electrified.

3.5.1.2. Specialized equipment for running boreholes.

In order for the greater part Maun Village to be provided with water, specialized equipment is needed to reach the functioning boreholes on a daily basis. The specialized watercraft used include three speed boats, one airboat, and two all terrain vehicles known as "hippo" and "amphibian".

These various types of watercraft are conducive to the different conditions of water levels in the Delta which fluctuate during different times of the year. Speed boats are ideal for deep waters. The airboat is used in marshy and/or shallow areas where a standard inboard or outboard engine with a submerged propeller (speed boat) would be impractical. The two all terrain vehicles are able to travel through terrains such as swamps, muddy, sandy and dry lands.

Management of some of the watercraft such as the hippo and amphibian is a challenge. They can breakdown anytime resulting in personnel failing to reach borehole sites during certain times of the year. In November 2012, the amphibian and hippo vehicles were down when their use was required since the water in the rivers was shallow, muddy and swampy. This left the DWA with the airboat and speed boats to use. Using speed boats become more difficult in shallow waters as the engine propellers can be constantly caught up in the weeds. It takes longer to reach boreholes sites in such a case, delays refueling and maintenance work on the boreholes, resulting in longer borehole downtime.

3.5.1.3. Electric power cuts.

Treatment plants which supply Ikoga and Ukusi with water are sometimes affected by electricity power cuts resulting in stoppage of the pumping process. The treatment plants have standby generators, but once there is a power outage the generators are not able to operate the system to maximum capacity. Settlements such as Ukusi do not receive water when there is a power cut. The power cuts usually last for up to nine hours. Sepopa and Mohembo West treatments plants can experience power cuts 6 times a month. Electricity for the plants is imported from Namibia. As a result, settlements may not have water for at least 54 h in a month.

3.5.1.4. Sand filtration challenges.

The Sepopa and Mohembo West treatment plants which supply water to Ikoga and Ukusi respectively use the slow sand filtration system to filter and chlorinate

water. The sand used has a limited lifespan. There is non-availability of granular sand in the district as the area has fine sandy soils only. The treatment plans are forced to use the available fine sand which causes the filtration process to be very slow. Blockages of filtration filters by fine sand are common as these can happen every five days. When blockages take place, casual laborers are hired to unblock the filters. The whole process causes disruptions in supplying water to settlements for 24 h or more.

3.5.2. Financial constraints

Reliable water supply in Ngamiland over the years has been constrained by limited financial resources on the part of DWA and the NWDC. Financial resources are required for the purchasing and installation of infrastructure as well as its operation and maintenance. Financial constraints faced by the DWA had negative effects on households of Maun while those constraints faced by NWDC had negative effects on settlements such as Matlapana, Somelo and Ikoga.

Budgets for water supply and distribution for the NWDC and DWA were provided by central government. Personnel from NWDC pointed out that funding for water supply was inadequate. As a result, there were not many new water supply projects. The NRDC concentrated on operating and maintaining existing water supply infrastructure and paying salaries. Funding for embarking on major capital projects, such as the Maun Phase II Integrated Water Scheme Up-grade project, aimed at upgrading and replacing infrastructure and drilling of new boreholes has been on the plans for some time due partly to financial challenges.

The financial position of NWDC was made worse by the fact that it was supplying water to almost 60 small and scattered villages in Ngamiland with a population of less than 500 people each. Moreover, according to legislation, district councils were supposed to supply water to settlements whose population is between 250 and 4999 people, but the NWDC supplied water to some ungazetted settlements. The situation was made worse by the fact that it was supplying Gumare and Shakawe with water yet these have populations that are more than 5,000. These two settlements were supposed to be supplied by the DWA. All this overstretched financial resources of the NRDC.

The budget for the Maun Administration Authority Water Unit shows that more than 50% of the funds was allocated to salaries and shot up to between 60% and 70% before water supply was handed over to WUC (Fig. 4). This resulted in budget line items such as running expenses and *de special* under which water supplies spares and the replacement of water equipment and private connections were funded being reduced respectively. The Water Unit of the Maun Administration Authority exhausted its 2012/13 budget in October 2012 and started relying on the council's general fund.

Officials from the DWA and NWDC pointed out that during the early 80s, the government could adequately fund water supply projects. The economic global recession which resulted in the demand of rough diamonds going down in 2008 negatively affected Botswana government's revenue as its economy is mainly supported by diamonds. Major buyers of diamonds which include India and China faces liquidity challenges and reduced their demand (Segwai, 2013). This resulted in the government not being able to adequately fund services which include water supply. Pressure from social problems such as HIV and AIDS also led the central government to spend more money on anti-retroviral drugs and taking care of orphans. The situation was worsened by the fact that DWA and district councils supply water at subsidized rates as they are not there to make a profit. The policy in Botswana is to make water available to residents at affordable rates. The head of the water section of Maun Administration Authority mentioned that since he has been in his position, NRDC water unit has been collecting 20% of their annual water budget from the consumers. Moreover, this money is not re-invested directly into water supply as it accrues to the general account of the NRDC. The head of the water unit of the Okavango Administration Authority said if the water unit was to be viable during the 2012/13 financial year, BWP26,000,000 (USD3,291,599.93) would have been adequate.

The tariffs charged by both the DWA and NRDC show that the thrust has been more to provide a social good mainly to poor households than to make profit (Table 4). There is a difference between the charging system of NRDC and DWA and the one for the WUC which operates along commercial lines. The WUC unlike the NRDC and the Water Affairs charges its water per cubic meter. WUC charges tariffs which are intended to cover costs and generate a target rate of return on capital invested.

Revenue collection by NWDC was also not strict as there were no disconnections done for defaulting households. The district council has been concerned with supplying households in small villages with water than the collection of money. Households which have not been paying their monthly water charges did not get penalized by the council in anyway. Engineers from the water unit said that councilors always resisted whenever they raised the issue of disconnecting defaulters. One of the councilors said if they were to be strict with water payments, most of the households would not be able to pay since they have very low income as well as income sources. The district council last sent water bills to households in Matlapana in 2009. One of the council officials said that it would be unfair to send water bills to households which have not had a reliable supply of water for a long time. The study also established that the computer which had information of private water connections for Matlapana crashed and there was no way in which bills could be generated.

As of November 2012, the DWA, Maun Station was owed BWP2,708,428 by defaulting residents. Some households in Maun said they prefer to pay their water charges after 3–6 months when the money would have accumulated. Some households said they pay about BWP30.00 every three months. In order to force residents to pay their water bills, the DWA started disconnections in July 2012 and this forced residents to pay.

During the 2011/2012 and 2012/2013 financial years NRDC could not procure materials such as water meters for villages like Ikoga due to budgetary constraints. As a result, households were connected without meters and charged a flat monthly rate of BWP4.50 (UDS0.53). The Okavango Administration Authority water unit lacks equipment such as vehicles, while the Sepopa treatment plant did not have a vehicle to enable surveillance of the pipeline or for attending to burst pipes.

Financial resources play a crucial role in enhancing water security and human security. Lack of financial resources is negatively affecting the supply of reliable water to Maun and other settlements in the district.

3.6. Water governance challenges

The main legal framework for water governance in Botswana is the Water Act of 1968. This is an old framework which does not capture current governance approaches such as integrated water resources management (IWRM). IWRM is "a process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems" (GWP, 2000). Operationally, IWRM approaches involve applying knowledge from various disciplines as well as the insights from diverse stakeholders to devise and implement efficient, equitable and sustainable solutions to water and development problems. As such, IWRM has to be underpinned by legislation and policy. This is lacking in

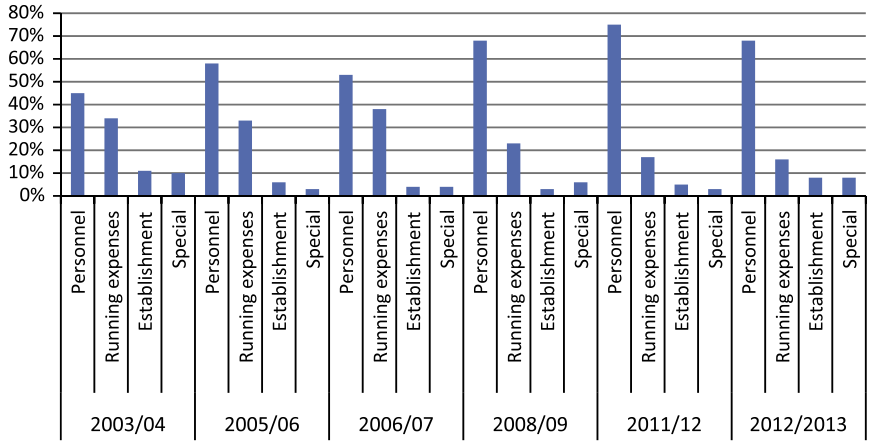

Fig. 4. Water budgets for the NRDC's Maun Administration Authority.

Table 4
Water tariffs.

NRDC		Water affairs		Water utilities corporation	
Consumption	Charge	Consumption (m^3)	Charge	Consumption (m^3)	Average charge per (m^3)
0–5 m^3	P1.50	0–5	P1.25	0–5	P1.89
6–20 m^3	P3.75	5–20	P3.20	6–15	P5.42
21–40 m^3	P7.80	20–40	P6.60	15–25	P7.58
>40	P9.50	>40	P8.15	>25	P8.92

BWP1 = USD0.123900 or USD 1 = BWP8.07103.

Botswana as the country has different old pieces of legislation such as the Borehole Act of 1956, the Waterworks Act of 1962, amended in 1983 and the Water Utilities Corporation Act of 1970, amended in 1978. These pieces of legislation are not integrated neither is their enforcement.

Two major institutions under different ministries have been involved in household water supply in Ngamiland until the end of March 2013. The DWA falls under the Ministry of Minerals, Energy and Water Resources and supplied water to Maun village while the NWDC falls under the Ministry of Local Government, supplied water to tertiary villages. There was not much coordination between these two entities as they functioned independently of each other. The DWA developed most of the infrastructure in tertiary villages and handed these over to the District Council for operation and maintenance. In order to speed up the development of such infrastructure, since 2009, private contractors were hired by the government.

There are areas where these institutions could collaborate in the supply of water to settlements such as in Matlapana but this did not happen. In some instances, infrastructure for water supply for DWA and NWDC ran parallel to each other. Both the DWA and NWDC supplied water to different sections of Disaneng ward in Maun. There are two water transmission lines to the area. Furthermore, both institutions had boreholes along the Thamalakane River and different transmission lines conveying water from these sources. The NWDC pipeline was for Matlapana and nearby villages while the DWA transmission line was for Maun but passes through Matlapana. Since Matlapana started experiencing water problems, the two institutions did not discuss the modalities of having DWA supplying water to this settlement. The residents of Matlapana were confused as to why they could not get water from a transmission line that passes through their area. Moreover, central government had to release financial resources to two different institutions, that is, DWA and district council to fund the same activity of water supply.

Water Utilities Corporation (WUC) took over the supply of water as from the 1st of April 2013 to all gazetted settlements in Ngamiland. However, residents in the study areas argue that they were not consulted on the WUC take over. They fear that WUC will introduce huge water charges. They highlighted that WUC was for cities and not poor settlements like Maun and other tertiary centers found in Ngamiland. They even said that if WUC takes over, they would rather fetch water from unprotected water sources. One woman in Maun said:

> "If this WUC comes, we would rather go back to fetching water from the river like what we used to do long back".

3.6.1. Socio-economic factors

Several socio-economic factors are implicated in water security problems experienced in Maun Village. Among these factors are rapid population growth and urbanization. These have increased the daily demand for potable water for the village. Maun has a demand of 8319 m^3/ day against a supply of 7830 m^3/day.[4] This means that there is a shortfall of 489 m^3/day.

3.6.1.1. Population growth. The settlement of Maun as the main administrative center of Ngamiland is urbanizing (i.e. changing from a traditional village to a settlement with an urban character) and thus experiencing immigration as well as natural population growth. According to the 2011 census results, Maun has 38% of Ngamiland's population. Table 5 shows how the population of Maun grew since 1981.

The population of Maun grew significantly between 1971 and 2011 (Table 6). This growth has not been matched with improvements in water supply infrastructure.

3.6.1.2. Urbanization. Maun as the capital of the North-West District has assumed a more urban character over the years. It has

[4] Department of Water Affairs, Maun water supply situation report, 22nd -24th August 2011.

Table 5
Population growth of Maun. *Sources*: Central Statistical Office, 1981, 1991, 2001 and 2011.

Settlement	1971	1981	1991	2001	2011
Maun population trend	9614	14,925	23,477	43,776	60,263
Percentage of Ngamiland population (%)	17.8	30.7	36.6	39.9	44
Growth rate (%)		2.4	3.3	2.8	2.45

Table 6
Developments of Main Village.

Development	<1999	2000–2012	Total
Residential areas	11	2	13
Shopping malls	2	1	3
Primary schools	11	7	18
Junior Secondary schools	3	1	5
Senior Secondary Schools	0	1	1
Botswana Meat Commission	1	Re-opened	1
The Maun International Airport	1	Expanded	1
Rural Administration Centers	1	1	2
Prison Complex	1	0	1
Hospitals	1	1	1
Hotels	3	0	3

experienced developments (Table 6) which put pressure on water resources infrastructure and has increased the demand for water. The district is also the hub of Botswana's tourism industry.

Infrastructure i.e. shopping centers, lodges, hotels, hospitals, houses, are associated with urbanization and require substantial amounts of water. This leads to the reduction of water availability for households in an area where water resources are already limited. The Village now has numerous small formal and informal industries some requiring large amounts of water on a daily basis. The larger population of the Village is concentrated in old residential areas such as Boyei and Wenela. This puts more pressure on the water supply infrastructure.

3.7. Water supply and distribution infrastructure

Water supply and distribution infrastructure play a critical role in water security. Settlements in general and those in Ngamiland in particular, need efficient and effective supply and distribution infrastructure aimed at satisfying current and future demand.

3.7.1. Water supply infrastructure

As mentioned earlier on, some of the boreholes which supply Maun Village and other settlements such as Matlapana and Somelo have not been operational for some time due to flooding which either submerged or contaminated them or both. Some of the boreholes developed technical faults. In the case of Matlapana, Somelo and sections of Maun, water problems became severe since 2009 when most of the boreholes were submerged by floods.

3.7.2. Water storage capacity

Maun Village does not have adequate water storage facilities. Water storage facilities for Maun Village are able to store 5365 m^3 against a daily demand of 8319 m^3. DWA has been able to supply 7830 m^3/day. This means that in the event of a breakdown of boreholes or treatment plants, the settlement has no adequate water storage facilities to provide households with water while any supply problems are being attended to. The desired water storage facility capacity for Maun Village is about 16,638 m^3. This would enable the area to store a supply of two days. However, government is in the process of constructing a 6000 m^3/day surface water treatment plant in Maun which is expected to start operating in September 2013.

3.7.3. Water distribution network

The water distribution network of Maun is not efficient as it is unable to cope with demand due to its layout and aging. The network is more than 30 years old and has not been upgraded. It was designed for a small population than it is catering for. As a result, it is estimated to be losing about 25% of the water[5]. Moreover, the network does not cover 32% of Maun. The network is complex and intricate as a result of the poor layout of most of the residential stands in Maun which do not follow a well planned format and standard (see Fig. 5). It is therefore difficult to apply systematic engineering principles to the network as it is laid out in a haphazard pattern. Some of the pipes' diameters have become too small for the demand as well.

This network is sometimes overloaded and overstretched resulting in frequent bursts. Moreover, some sections of the network are only identified when there are pipe bursts. There is not readily available information on the whole of Maun's network layout. Pipe bursts and leakages are frequent resulting in interruption of supply and contamination of water. Interruptions in water supply as a result of pipe bursts could last for periods ranging from 3 h to 3 days depending on the severity of the problem.

Pipe bursts contaminate water already in the network. Water supply and distribution interruptions cause the network to develop algae and rust thereby contaminating the water when flow is restored. There are plans under the Maun Integrated Water and Sanitation Scheme Upgrade Project Phase II to replace the whole network.

Surface water in Maun village is treated for turbidity and bacterial contamination. The DWA laboratory has 17 points from where it collects samples for regular testing. The water is tested for microbiology each week before it goes into the network and as it exits. For chemical composition, the water is within the specified limits. The quality of underground water depends on the location of the borehole. Bacterial contamination for underground water shows a reading of zero. Underground water is not treated as conductivity and total dissolved solids in the water are said to be within the specified limits. This being the case, residents complain that the water is hard, and has an unusual color and taste.

There is an urgent need for the water distribution network for Maun Village to be upgraded so that it would be able to cope with demand. This will also minimize cases of contamination of the water when pipe bursts are experienced.

3.8. Demand for individual household connections

As Botswana has been moving towards the provision of water for all, the approach in different settlements has been the installation of communal water sources within a distance of 250 m of households. Thus, over the years, the majority of the households accessed water from communal sources. Most households in large settlements such as Maun, now prefer private water sources either within their residential premises or inside their houses. This has seen the demand for private connections rising steadily since 2000 (see Table 7).

Table 7 highlights that since 2000, the number of private connections in Maun Village has increased. This also leads to increased

[5] Interview with the DWA Distribution Manager.

Fig. 5. Layout of residential properties in Boyei and Wenela wards. (Source: Ngami Data Services, 2011)

Table 7
Trends in the increase in private water connections in Maun Village.

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Number of private connections	3236	3934	4898	5348	–	6345	6931	7490	8289	9348	10,535	11,259	11,879

consumption of water in the village. Sixty-five percent (65%) of households in Maun Village who moved from communal taps to private connections, said that their water consumption increased by between 30% and 150%. Demand for private connection has also been increasing in tertiary centers settlements such as Matlapana. All (100%) of households with private connections in Maun Village and other gazetted settlements feel that such connections greatly contributes to equitable access to water as they are not limited on how much they should consume on a particular day when there is constant supply.

The fact that many households in Maun, prefer private connections, calls for a water demand management strategy that would influence reasonable water consumption at the household level.

4. Discussion

The goal of all nations in both the developed and developing world is to achieve water security for their citizens (Zeitoun, 2011). Developed countries have attained a higher degree of water security as 100% of their population has access to safe and clean water through improved sources (WHO/UNICEF, 2012). A series of reforms in water and sanitation embarked on by governments in the western world where water and sanitation were placed at the center of their development agenda dramatically enhanced water security and overall human security as well as social progress from the 19th Century onwards (UNDP, 2006a). Before that time, cities were centers of infectious disease, i.e. diarrhea, dysentery and typhoid fever due to water insecurity. Developed countries managed to put in place the policies and legal frameworks, financial mechanisms and technologies needed to enhance water and human security (UNDP, 1994, 2006a).

Organizations such as the G8, the GWP and the United Nations have made efforts aimed at the attainment of water security in developing nations. However, these efforts are still to yield positive results as the world today is confronted with a serious water security problem which has the potential of ultimately affecting human security (Falkenmark and Rockstrom, 2004; Pahl-Wostl et al., 2008; Jones et al., 2009; Vörösmarty et al., 2010; Manzungu and Chioreso, 2012). Southern Africa has only three countries (i.e. Botswana, Namibia and South Africa) which have between 91% and 100% of their populations obtaining drinking water from improved sources (WHO, 2010). Countries such as Democratic Republic of Congo, Lesotho and Mozambique have less than 50% of their population accessing water from improved sources while Angola, Zambia, Kenya and Tanzania are in the 50–75% category (WHO, 2010). Zimbabwe which had made strides in ensuring access to water to its population through improved sources between 1980 and 1999, experienced a political crisis between 2000 and 2009 which reversed gains made earlier (Manzungu and Chioreso, 2012).

Botswana has made significant strides in ensuring access to water through improved water sources (Kgomotso and Swatuk, 2006). The country is well ahead of other African countries in terms of efforts in extending clean water services. Botswana has deliberately pursued a policy of ensuring equitable access to water for households in different settlement categories (Arntzen et al., 2000). This policy ensures that households in some settlements which cannot afford to pay higher water charges access water for free from public standpipes (Arntzen et al., 2000; GoB, 2009). However, the concept of equitable access to water is lost when it comes to households located in ungazetted settlements which do not receive any water services (Swatuk and Kgomotso, 2007). Such households have to rely on water from untreated sources. Moreover, the concept of equity loses its major aim as households fail to access water from their main sources as a result of various factors highlighted in this paper.

Though 96% of Botswana's population has access to improved water sources this has not guaranteed availability of water to households in some parts of the country including Ngamiland (Kgomotso and Swatuk, 2006). The percentage of the population with access to improved water sources for Botswana gives the impression of a country that has achieved water security for households in different settlement categories. However, this masks the reality of water security problems faced at the local level, especially by households in different settlement categories of Ngamiland district. Though water infrastructure has been put in place, water security problems, especially prolonged shortages as well as water quality problems, persist across the country in general and in Ngamiland in particular. Little attention is paid to the population living in ungazetted settlements (Kgomotso and Swatuk, 2006; Swatuk and Kgomotso, 2007) which makes up a significant percentage (87%) of the settlements of Ngamiland (GoB, 2003).

Water security problems in different settlement categories of Ngamiland are caused by an interaction of both natural and

manmade factors which include climatic and hydrological, technical, socio-economic, financial, water supply and distribution infrastructure, water governance challenges and increased demand for individual connections. Households in different settlement categories of Ngamiland have experienced water security problems in the form of inaccessibility, inadequate quantity of water as well as poor quality. These water security problems are a threat to human survival since there is no substitute for water (Savenije, 2002). Water security problems have the potential of negatively affecting the health of household members as well as their productive capacity as excessive time is spent fetching water (UNFPA, 2009). Thus, the water security problems being experienced in different settlement categories of Ngamiland present an existential threat to households and their individual members (Buzan et al., 1998).

In order to enhance water security as well as human security in different settlement categories of Botswana and Ngamiland in particular, there is need to put in place institutional systems in the form of laws and policies which provide an effective framework for water management. It is important for policy makers and planners to take into consideration the contribution of different factors in water security. Factors such as climatic and hydrological factors, financial resources, socio-economic issues and governance need to be given an important priority in legal and policy formulation.

Climatic and hydrological factors which contribute to water security problems in all settlement categories of Ngamiland need serious consideration when drafting water policy and legislation as well as when planning and implementing projects aimed at addressing water security problems. Policy and planning has to spell out how households can access water for domestic purposes in the context of inter and intra-annual rainfall variability and its spatial distribution variation. Since households in most settlements rely on groundwater resources, it is important to come up with a holistic and integrated framework on the sustainable exploitation of both groundwater and surface water resources.

Any plan for enhancing water security has to critically take into consideration issues of water quality. Water service providers have to supply water of an acceptable quality to households in different settlement categories. Contamination of water by arsenic need to be taken into consideration in any present and future water planning. There is need for more research which can conclusively establish sources of arsenic contamination for both surface and groundwater in Ngamiland. Knowledge of occurrence, origin and distribution of arsenic is vital for reducing and avoiding its existential threat to the population of Ngamiland. It is critical to assess arsenic exposure to the population of Ngamiland so as to come up with a strategy of safeguarding human health and lives. Public awareness on water contamination and environmental impact of arsenic contamination will have to be increased (Wang and Mullingan, 2006).

Water security for households entails investment of financial resources in infrastructure and management. The government of Botswana, has to some extent, been able to invest in improved water sources for households in different settlement categories. However, some of the sources are not able to continuously provide water resources. There is need for more financial investments such as in raising platforms for boreholes located along river channels as well as electrifying them and consider the use of telemetry. This would solve the technical problems related to the reliance on human labor, use of diesel engines in the operation of boreholes and use of specialized watercraft. The upgrading of the water storage tanks as well as the water distribution network would also require substantial financial investments. It is critical for legislation and policy to be explicit on how such water development projects are to be funded, maintained and operated. The level of contribution by the government and that of the consumers need to be highlighted. In most instances, government becomes overburdened with the provision of social services such as water. Though Botswana subscribes to the IWRM approach (Hirji et al., 2002) which has as one of its principles, the need for water resources to be recognized as an economic good requiring users to pay the economic cost, this is not being applied mainly because the government of Botswana believes in protecting the poor by making water available at an affordable price or for free.

Botswana has to operationalise IWRM which promotes a holistic and integrated approach in water governance in the quest to achieve water security (GWP, 2000). It has been argued that, the water crisis that the world is experiencing is a crisis of governance as there are no proper and adequate systems in place to ensure that everyone has access to water for both domestic and productive purposes (GWP, 2000). This scenario could be true for Botswana where over the years there has been different service providers for domestic water supply, a situation that engenders confusion over which provider is responsible for what role and pricing distortions. A clear policy and legislative framework which spells out a single service provider such as the WUC, would help in dealing with issues related to the role of the service provider and pricing (GWP, 2000a). Effective water governance is underpinned by such a policy and legislative framework. Such a framework would enable investments which ensure that an increasing population as well as an urbanizing settlement is catered for in terms of domestic water supply.

The full adoption and implementation of IWRM by Botswana would enhance organized and coordinated planning in the area of water supply in large settlements such as Maun as well as small villages in Ngamiland, both gazetted and ungazetted settlements. Integrated and holistic organized planning would help in tackling the problems related to the water storage capacity and distribution network. The operationalization of IWRM in Botswana would ensure stakeholder participation in the service provision of domestic water to households by encouraging the residents or households to have a greater role to play.

5. Conclusion

A multiplicity of factors, natural and manmade, can threaten household water security as well as equity and human security. Households from both gazetted and ungazetted settlements in Ngamiland are affected by water security problems as a result of a combination of such factors. Identifying specific factors affecting water security in Ngamiland can help policy makers and planners to craft effective strategies aimed at addressing the problem of water insecurity and inequity in different settlement categories of Botswana in general and Ngamiland in particular. At the moment, water security in Ngamiland is not optimal and there is need to address the situation so that households in different settlement categories can be water secure so as to enhance their human security status.

Based on data presented in this article, Ngamiland's water security is affected by limited surface water and groundwater resources due to climatic and hydrological conditions. Water security is further compromised by other factors such as population growth in Maun as well as water governance challenges, financial constraints and technical factors. This calls for long term water resources supply and management planning which need to consider all possible options. This has to be done taking into consideration the varying needs of different settlement categories.

It is recommended for Botswana to develop a water resources management policy that takes into consideration the different settlement categories, whereby, large villages have to address factors related to climatic and hydrological factors, demographic changes, urbanization, management challenges and water supply

infrastructure and introducing water demand management activities while households in small villages need provision of water from more sustainable sources. Ungazetted settlements which constitute a significant percentage of settlements in Ngamiland need to be considered in this strategy.

In order to enhance water governance and to promote water security, Botswana has to come up with a water legislation and policy framework which reflects the current operating environment as well as current ideas about water security. Such framework has to highlight water resources management approaches that enhance water security as well as human security in different settlement categories. A major step would be the development of a comprehensive water resources management policy underpinned by IWRM principles that guarantee access to water to households in different settlement categories. Such a policy has to address factors which include climatic and hydrological factors, water governance, extreme events such as drought and floods, financial constrains, demographic changes, water supply infrastructure and supply of water in all settlements.

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CHAPTER FOUR

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Short and Long Term Strategies for Household Water Insecurity in Ngamiland, Botswana

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Abstract

The paper analyses coping (short-term) and adaptation (long-term) strategies by households to address water insecurity in Ngamiland, Botswana, a middle income and semi-arid country. Quantitative (i.e. structured household questionnaires) and qualitative (i.e. key informant and informal interviews, focus group discussions and participant observation) approaches were used. The concept of water security and the actor-oriented approach inform the paper. Households in Ngamiland are experiencing water insecurity and they mainly employ coping (i.e. accessing untreated water, traditional rainwater harvesting, bulk water hauling and buying, use prioritization, and buying bottled water) as opposed to adaptation (i.e. abstracting groundwater, connecting storage tanks to main water systems and modern rainwater harvesting) strategies to deal with water insecurity. More scientific research for informing water policies and implementation of sustainable water supply strategies is required in order to enhance water security in countries like Botswana.

Keywords: actors, adaptation, Botswana, coping, households, insecurity, security, strategies, water

1. Introduction

The world's freshwater resources are currently under considerable stress as demand is outstripping supply in many regions including sub-Saharan Africa (Chamberlain, 2008; Hanjraa & Qureshi, 2010; Rogers, 2008; Rosegrant, Cai, & Cline, 2002). In 1995, the world withdrew 3 906 km^3 of water and this is projected to increase by at least 50% by 2025 as more water will be required for agricultural, domestic and industrial purposes (Gleick & Palaniappan, 2010). Global freshwater withdrawals have tripled over the last 50 years and the demand for freshwater is increasing by 64 km^3 a year (Gleick & Palaniappan, 2010). Globally, the growing regional, national, and seasonal water scarcities pose severe challenges for national governments in the provision of water for domestic, productive and environmental purposes (Ringler, Bryan, Biswas, & Cline, 2010).

Developing countries are being affected most by freshwater scarcity because of climate change and variability, rapid population growth, urbanization and ineffective water governance systems (Banerjee et al., 2008). An estimated 1.1 billion people still lack access to safe water sources, despite considerable investments in water and sanitation in developing countries since the 1980s (Onda, LoBuglio, & Bartram, 2012; WWC, 2000). Nearly 80% of the people using water from unimproved sources are concentrated in sub-Saharan Africa and eastern and southern Asia (Hutton, Haller, & Bartram, 2007). Currently in sub-Saharan Africa, 56% of the population has access to safe water and 39% of the urban population is connected to piped water compared to 50% in the early 1990s (Manzungu, Mangwanya, & Dzingirai, 2012). Across Africa, water insecurity (inadequate access to water, access to poor quality water and insufficient water supply and distribution facilities) (Webb & Iskandarani, 1998) has led to outbreaks of waterborne diseases such as cholera in Zimbabwe which killed over 4 000 people in 2008-2009 (Manzungu & Chioreso, 2012; Mason, 2009), and rota virus in Botswana's Ngamiland District which killed 18 children under the age of 24 months in 2012 (Morokotso, 2012).

Households affected by water shortages and lack of supply usually devise coping or adaptation strategies to counter the situation. Poorer households usually use untreated water during periods of shortages or where water supply services do not exist (Kgomotso & Swatuk, 2006; Manzungu & Chioreso, 2012; Swatuk & Kgomotso,

2007). Wealthier households are better off in adapting to water supply problems by investing in private boreholes, storage tanks, and purchasing bulk water (Manzungu & Chioreso, 2012; Manzungu et al., 2012).

Coping denotes short-term actions responses by households to extreme events, such as storms, drought or water shortages, to ensure immediate survival but which often results in a long-term decrease in wellbeing (Few, 2003). Coping takes place in the absence of pro-active adaptation that reduces vulnerability of households to extreme water insecurity. There is autonomous coping which refers to responses implemented by households in the context of perceived or real water insecurity without intervention and/or co-ordination by regional, and national government and development agents (Bates, Kundzewicz, Wu, & Palutikof, 2008) and planned coping which refers to changes in policies and institutions with a focus on developing approaches which enhance household water security (Adeniji-Oloukoi, Bob, & Moodley, 2013).

Adaptation refers to the process or outcome of a process that leads to a reduction in harm or risk of harm, or realization of benefits associated with a phenomenon such as water insecurity (Bedsworth & Hanak, 2010). Adaptation is a planned and long-term process. There is reactive adaptation which refers to the immediate response to a risk often used to regain stability which is not capable of reducing the long term damage of a risk (Fussel, 2007; Smit, Burton, Klein, & Street, 1999). Proactive adaptation involves long-term decision-making which improves the ability to cope with future risk and reduces the long-term damage and vulnerability due to the risk (Adger, Arnell, & Tompkins, 2005; Smit & Wandel, 2006).

This paper offers some insights from research work and literature on how households in a semi-arid country devise short and long-term strategies in dealing with water insecurity. The analysis in the paper offers policy recommendations on the development of sustainable strategies for enhancing household water security in order to do away with unsustainable coping strategies, which the majority of households are adopting.

2. Analytical Framework

Household coping and adaptation strategies to water insecurity are analyzed using the actor-oriented approach (Long, 1988, 1990, 1992; Long & Van der Ploeg, 1994) and the concept of water security (Cook & Bakker, 2012; Grey & Sadoff, 2007; GWP, 2000; Lautze & Manthrithilake, 2012; Vörösmarty et al., 2010). Water security refers to access to enough safe water at affordable cost to lead a clean, healthy and productive life while ensuring that the natural environment is protected and enhanced (GWP, 2000). The concept of security broadly entails protection from the risk of water shortages, poor water quality and lack of water supply services. Strategy refers to a plan of action designed to achieve a specific aim (Kujinga & Manzungu, 2004).

The analysis is done using concepts of the actor-oriented approach, i.e., actor, agency, heterogeneity and lifeworlds. The term actor is a social and cultural construction and refers to individuals, households, groups and institutions performing actions individually or as a cohesive unit. Ensuring – for example in this context – that the household copes or adapts to water insecurity (Magadlela, 2000). The use of the approach facilitates the identification of different actors, their interests, objectives and organizing strategies (Magadlela, 2000). The household concept denotes an institution of two or more people (not necessarily permanent), whose primary feature is co-residence, eating and pooling resources together as well as involvement in the provision of essential resources required for a living (Rakodi, 1991; UN, 1976).

Actors live in a particular lifeworld, i.e. the actors' view of themselves and their everyday lives. This encompasses how they view the outside world and interpret new innovations using their conceptual tools acquired in their own world view (Magadlela, 2000). This also refers to how actors organize themselves in coping and adapting to a phenomenon such as water insecurity.

The concept of human agency attributes to the actor/s, the capacity to process social experience and to devise ways of coping with life, even under difficult conditions (Long, 1992). In difficult and seemingly hopeless situations they can have the agency to devise strategies or alternative ways of accessing water for domestic purposes.

Households facing insecurity can generate heterogeneous forms of coping and adaptation strategies as a result of the assets, income and networks they have (Long & Villarreal, 1994). The concept of heterogeneity helps to analyze different coping and adaptation strategies adopted in the same or different settlement categories by different households as they endeavor to reduce risk.

3. Materials and Methods

3.1 Study Area

The study was undertaken in the North-West District (commonly known as Ngamiland) in Botswana (Figure 1). The district's population at last census was recorded as 158 104 (Central Statistical Office, 2011). The district is administered by the North West District Council (NWDC) and is sub-divided into Ngami (administered from Maun Village) and Okavango (administered from Gumare) Sub-district Authorities. Maun Village, with a population of 60 263, according to the last census, is the district's main administrative center (Central Statistical Office, 2011). The region's main physical feature is the Okavango River system shared between Angola, Botswana and Namibia. On the Botswana side the river forms a large in-land delta-like feature (actually an alluvial fan) and an important Ramsar site, known as the Okavango Delta (McCarthy & Ellery, 1998; McCarthy, Ellery, Rogers, Cairncross, & Eller, 1986). The main commercial and economic activities in the district include tourism and livestock rearing (Motsholapheko, Kgathi, & Vanderpost, 2010). Households classified as poor (i.e. living below the poverty datum line) in the district constitute 37.6% of the population, while an estimated 15.3% of the adult population is unemployed (CSO, 2011).

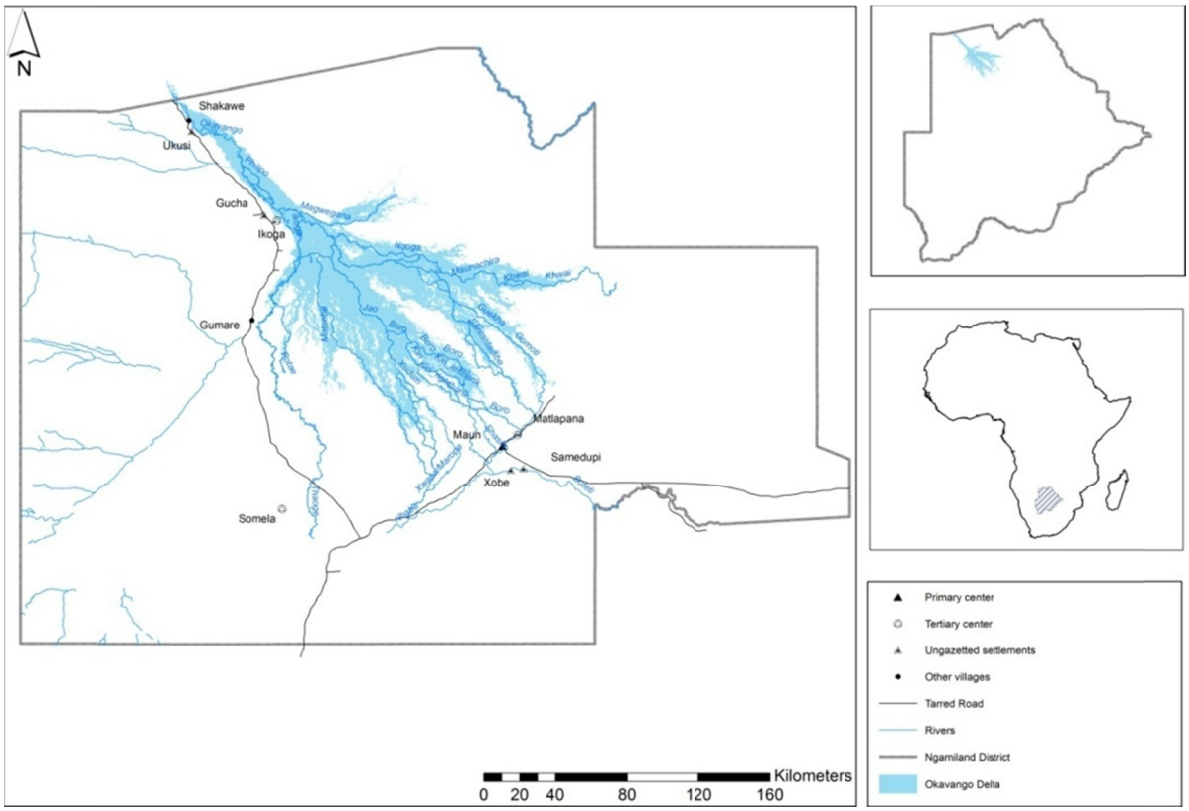

Figure 1. Study sites in Ngamiland

The study was undertaken in gazetted and ungazetted settlements. Gazetted settlements are formally recognized by the central government and receive services such as water supply, roads, schools, health and police (Government of Botswana, 2009). The establishment of gazetted settlements is based on population size, water availability, economic potential, employment generation among other factors (Government of Botswana, 1998). Gazetted settlements are ranked as either primary, secondary or tertiary centers (Government of Botswana, 1998).

Primary centers are subdivided into I, II and III mainly based on population size and services they offer (Government of Botswana, 1998). Primary centers I have a population of at least 100 000 (e.g. Gaborone) and are cities. Primary centers II have a population of between 50 000 - 99 999 and Primary centers III have a population range of 20 000 - 49 999 (e.g. Maun Village in Ngamiland District). Secondary centers are intermediate centers with a population range of 10 000 -19 999, e.g. Gumare in Ngamiland (see Figure 1).

Tertiary centers have population ranging from 250 - 9 999 people and are divided into sub-categories I – IV as follows:

(1) Tertiary center I, 5 000 - 9 999;

(2) Tertiary center II, 1 000 - 4 999;

(3) Tertiary center III, 500- 999;

(4) Tertiary center IV, 250- 499.

Tertiary centers sub-categories II – IV are the ones found in Ngamiland. There are no settlements which meet the criteria set for tertiary centers I.

Ungazetted settlements (mainly cattle posts) are informal and have populations of less than 250 people and are not entitled to service delivery.

3.2 Water Supply Services

Three institutions have been responsible for domestic water supply in Botswana, i.e. Water Utilities Corporation (WUC), Department of Water Affairs (DWA) and District Councils (Swatuk & Kgomotso, 2007). Until March 2013, WUC supplied water to urban areas, DWA to major villages and District Councils to small/medium rural villages. Water sector reforms, which commenced in 2009 identified WUC as the appropriate institution to supply water to all gazetted settlements nationally. The WUC took over water supply in Ngamiland in April 2013.

3.3 Methods

In order to ensure validity of results and avoid methodological artifact (Berg, 2004; Denzin, 1978; Denzin & Lincoln, 2008), the study used quantitative and qualitative data collection methods and water quality testing.

A structured household questionnaire, administered between May and August 2012, was used to collect quantitative data. These data included general household characteristics, household water sources, distance to the source/s, water shortages or supply experienced, extent of water insecurity and coping and adaptation strategies employed.

Qualitative methods were used to collect quality data on meanings, opinions, feelings and perceptions related to coping with and adaptation to water insecurity. The use of qualitative methods required that the researchers be immersed in the actors' lifeworlds in order to grasp what they experience, i.e. water shortages, lack of supply, poor water quality and how coping and adaption strategies are devised (Schwandt, 1994). Qualitative data collection took place between February 2012 and March 2014. The methods used include key informant and informal interviews, participant observation and focus group discussions (FGDs). Key informants interviewed include village development committee (VDC) members, ward councilors, traditional leaders and officials from WUC, NWDC and DWA. Ordinary community members attended FGDs. Participant observation was done in all the settlements including Matlapana where one of the researchers lived for 3 years.

Water samples were collected from household's water sources (i.e. private and public connections, borehole and river points) for micro-biology testing. Samples were collected before the onset of the rainy season in 2013 and after the rainy season of 2012/13. More samples were collected during the rainy season of 2013/14. According to Botswana water quality standards drinking water should not have any micro-biology counts per 100 milligrams of water (Botswana Bureau of Standards, 2009).

3.4 Sampling

The study was undertaken in 8 purposively sampled settlements, i.e. Maun (primary centre), Matlapana, Somelo and Ikoga (tertiary centers) and Xobe, Samedupi, Gucha and Ukusi (ungazetted settlements) (see Figure 1). These settlements were sampled for various reasons (Table 1).

The study uses the settlement and the household as units of analysis. A total of 554 questionnaires were administered through the assistance of enumerators. A 30% sample size was adopted (Table 1) using lists obtained from the national census, district council and local village leadership. Households in each settlement were listed and each was assigned a number. A random number generator selected households from which respondents were interviewed. Household members from 15 years (62% women and 38% men) and above, knowledgeable about the household's coping and adaptation strategies to water insecurity were interviewed.

Table 1. Sample sizes by settlement

Settlement	Settlement category	Population size (2011)	Total number of listed households	Number of households sampled	Reasons for sampling
Maun[1]	Primary center III	4105	933	295	The only primary center settlement in Ngamiland. Household and experience frequent water shortages
Matlapana A	Tertiary center II	1449	329	99	A settlement experiencing acute water shortages since 2009.
Ikoga	Tertiary centre III	673	153	46	Receives water supply from a surface water treatment plant
Somelo	Tertiary centre IV	600	136	41	Located 40 km away from surface water resources. Has saline groundwater resources
Gucha	Ungazetted	88	20	20	Located further away from a perennial water source
Samedupi	Ungazetted	286	65	20	Households are located close to a perennial water source
Ukusi	Ungazetted	261	60	19	Receives water supply services
Xobe	Ungazetted	260	60	20	Households are located close to a perennial water source
Total		7722	1571	554	

Sources: Central statistical Office 2011; Study settlements' records.

[1] Two wards in Maun (Boyei and Wenela) represented the Village. Boyei experiences extreme water shortages while the situation in Wenela is not serious.

Key informants were purposively sampled. The FGDs were attended by at least 16 participants from each settlement. Each group consisted of males and females from 15 years old and above. However, most groups had a ratio of 1:3 for men to women. The FGD participants were a mixture of household heads and other members.

Water samples for water quality testing were collected from sources where households access water (Table 2). Some of the sources such as public standpipes in Somelo did not have water at the time of sampling.

Table 2. Water samples collected from different settlements

Number of samples collected→	Gucha	Ikoga	Maun	Matlapana	Samedupi	Somelo	Ukusi	Xobe
Sampling points ↓								
Private standpipes	n/a	1	9	1	n/a	1	n/a	n/a
Public standpipes	n/a	-	n/a	1	n/a	1	1	n/a
Borehole	n/a	n/a	n/a	n/a	n/a	1	n/a	n/a
Untreated source	1	1	1	1	2	n/a	n/a	2
Water tanker	n/a	n/a	n/a	n/a	n/a	2	n/a	n/a

3.5 Data Analysis

Quantitative data, i.e. responses from the household survey questionnaire were analyzed using the Statistical Package for Social Sciences (SPSS) version 21. Six variables from the household survey, i.e. settlement category, settlement, household, income and main sources of water were selected as independent variables for analysis purposes. Non-parametric tests in general and Kruskal-Wallis 1-way ANOVA in particular was used in the analysis since the data was not normally distributed. Kruskal-Wallis 1-way ANOVA test was used as it can determine differences between attributes of non-parametric variables. The Pearson's chi-square test was used to determine association between variables, which include income and settlement, settlement and fetching of untreated water during times of water insecurity and settlement category and distance to untreated water sources. Cross tabulations were used to analyze interrelations between two variables (i.e. independent and dependent variables) and the interaction between them. Dependent variables analyzed, relate to short and long term strategies to household water insecurity.

Data from FGDs, key informant interviews and participant observation were categorized into broad themes of coping (short-term) and adaptation (long-term) strategies to water insecurity. Coping strategies were further sub-categorized into themes related to household water sources during times of water insecurity, methods used to fetch water, quality of the water, prioritization and storage of water during periods of water insecurity and buying of bottled water. Sub-themes related to adaptation strategies include drilling of boreholes and wells by households, harvesting water using proper equipment and connecting storage tanks to main water systems.

Water samples were analysed in the laboratory for three micro-biology parameters, i.e. faecal coliforms, faecal streptococci and total coliforms, and the results were compared against the requirements of drinking water specifications for Botswana (Botswana Bureau of Standards, 2009). Drinking water can be contaminated directly or indirectly, by human or animal excreta and microorganisms contained in faeces, harmful to health (WHO/UNICEF, 2013). Microbiology laboratory tests were used to determine faecal and total coliforms and faecal streptococci in drinking water. A faecal coliform is a facultatively anaerobic, rod-shaped, gram-negative, non-sporulating bacterium while faecal streptococci are germs present in the intestines of warm-blooded animals whose presence in large numbers in water represents contamination by excrement and possibly contain other disease-bearing pathogens (WHO, 2002). Total coliforms represents bacteria that are used as indicators of faecal contaminants in drinking water (WHO, 2002).

4. Results

4.1 Socio-Economic Backgrounds of Households

Across all the study settlements, there are more female headed (53%) households than male headed (47%). The majority of the household heads (99.6%) are above 18 years. The average household size across all the settlements is 5.9, as opposed to 4.4 for Ngamiland District (CSO, 2011). According to Pearson's chi-square test, there are no significant differences in terms of average household sizes among the different settlement categories.

Each household uses 69 L of water on average per day during periods of water shortages. This translates to 11.6 L per person per day. At least 20 L per person day of clean water is recommended (Aquaterra, 2008). An average of 250 L of water is consumed per day by each household if water is readily available. This translates to 56 L per person which is recommended by other water experts as being sufficient for an individual (Peter & Gelick, 1996). However, this is low compared to Botswana's national daily per capita of 150 L (UNDP, 2012).

In terms of household income (generated from formal and informal sources), there are significant differences across the different settlement categories (Figure 2). Income from livestock sales was not considered in the study as Botswana Meat Commission does not currently buy from Ngamiland farmers due to prevalence of the foot and mouth disease in the district. There is a strong statistical association between income and settlement category (Pearson's chi-square value = 303.060[a], degrees of freedom = 35, p = 0.000) significant at 5% level. Relatively higher incomes, (>BWP5,000[1]) are found in Maun and Matlapana while low incomes (<BWP500) are found in ungazetted settlements and some tertiary settlements, e.g. Ikoga and Somelo.

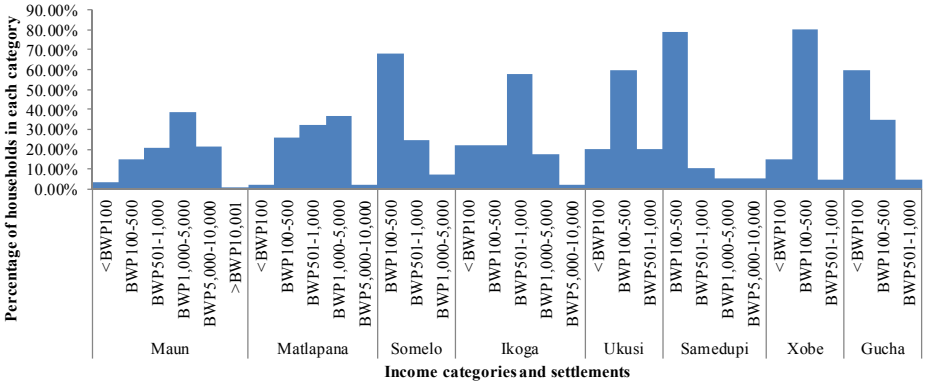

Figure 2. Household monthly income

The relatively low incomes in Ngamiland contrast markedly with the gross national income (GNI) per capita for Botswana (an upper middle income country) pegged at USD13,102 in 2013(UNDP, 2013).

4.2 Sources of Water

Eighty-eighty percent (88%) of the households in Ngamiland District, access water from improved water sources whenever supply is available (Figure 2). Improved sources of water in gazetted villages include public standpipes (23.1%), standpipe into yard outside the house (46.8%), standpipe inside the house (10.8%) and neighbour's standpipe (7.2%) (Figure 3). The 12% of households accessing water from untreated sources are mainly from ungazetted settlements. However, 30 ungazetted villages (e.g. Ukusi) that are located along water transmission lines receive water supply services in the Okavango Sub-district area. Members of parliament and ward councilors lobbied the Okavango Sub-district Authority during the late 1990s for water supply to such settlements since they are strategically located. However, Gucha does not benefit from a similar arrangement despite its location along a water transmission line. This is because the settlement came into existence after other ungazetted settlements had already been connected and a decision subsequently made by the sub-district Authority not to connect such settlements in order to discourage them from mushrooming.

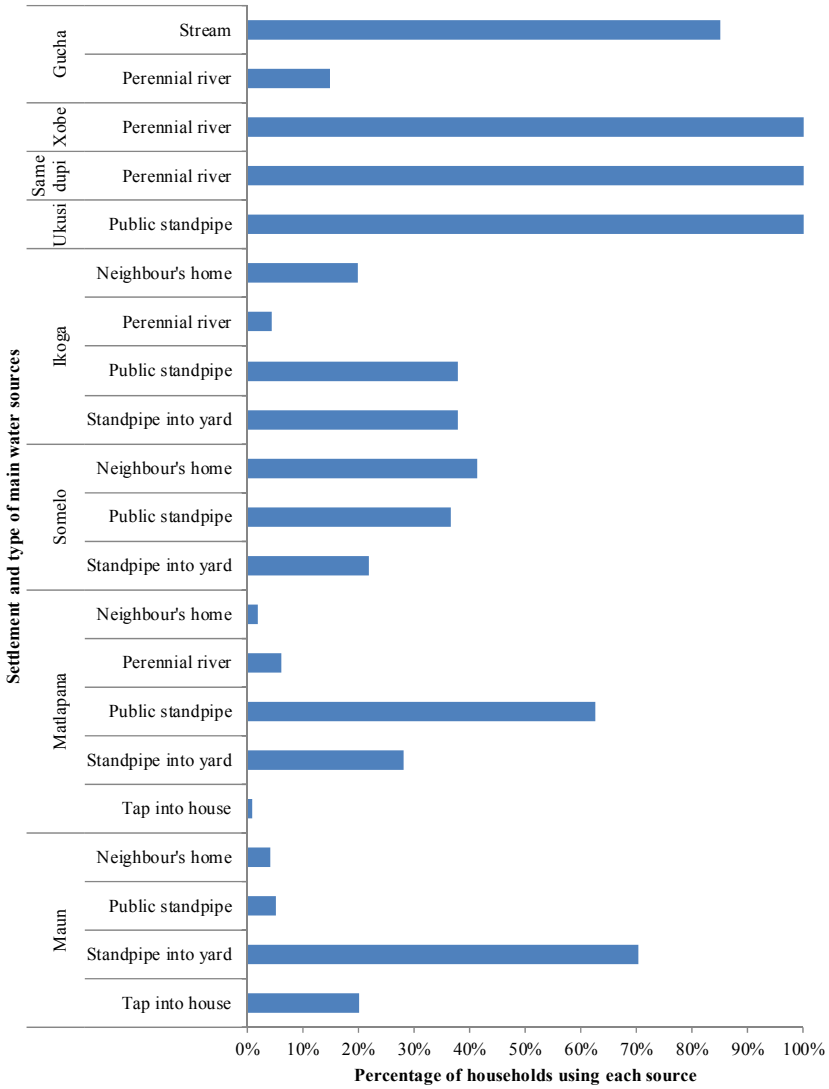

Figure 3. Main water sources for households

Households in Maun mostly have their own standpipes due to higher incomes, which enable them to afford the extra cost of private connections. Tertiary settlements, e.g. Ikoga, Matlapana and Somelo have a significant number of households with private water points while others use public water points as a result of variations in socio-economic status. Ungazetted settlements households, e.g. Samedupi and Xobe access water from untreated sources due to lack of improved water sources. Kruskal-Wallis 1-Way ANOVA test shows that there are significant differences ($p = 0.000$) in terms of water sources used in different settlements (Table 3).

Table 3. Comparison of water sources between settlements – Kruskal-Wallis 1-way ANOVA

Village to village relationship	F - statistic	Significance level
Maun-Matlapana	-151.120	0.000**
Maun-Ikoga	-161.410	0.000**
Maun-Ukusi	206.313	0.000**
Maun-Somelo	-220.432	0.000**
Maun-Xobe	-284.263	0.000**
Maun-Samedupi	-288.688	0.000**
Maun-Gucha	-317.588	0.000**
Matlapana-Ikoga	-10.209	0.714
Matlapana-Ukusi	-55.193	0.187
Matlapana-Somelo	-69.312	0.015*
Matlapana-Xobe	133.143	0.000**
Matlapana-Samedupi	-137.568	0.000**
Matlapana-Gucha	-166.468	0.000**
Ikoga-Ukusi	-44.903	0.336*
Ikoga-Somelo	-59.022	0.071
Ikoga-Samedupi	-127.278	0.001**
Ikoga-Gucha	-156.178	0.001**
Ukusi-Somelo	-14.119	0.631
Ukusi-Xobe	-77.950	0.058
Ukusi-Samedupi	-82.375	0.049*
Ukusi-Gucha	-111.275	0.028*
Somelo-Xobe	-63.831	0.039*
Xobe-Samedupi	4.425	0.921
Xobe-Gucha	3.325	0.767
Samedupi-Gucha	-28.900	0.846

**Highly significant at<p=0.001.

*Significant at p=0.05.

Most public standpipes in gazetted settlements are not functional (Table 4). According to the DWA and NWDC, residents vandalize public standpipes and expect them to be repaired at no cost to them. Households in Maun complained that DWA closed down public standpipes as a way of forcing them to invest in private connections. The WUC has plans to rehabilitate all public standpipes and install pre-paid water points.

Table 4. State of public standpipes

Settlement		Functional public standpipes	Non-functional public standpipes
Ikoga		2	7
Maun	Boyei	1	9
	Wenela	0	3
Matlapana		2	8
Somelo		1	2

4.3 Household Water Insecurity

Water security is perceived by households from different settlement categories as the continuous and uninterrupted availability and accessibility of good quality water from improved sources. On the other hand, water insecurity is viewed as unavailability of water from improved sources for a period ranging from 1 hour to years and availability of water of poor quality, i.e. discolored, bad smell or with some sediments.

Households from different settlement categories in Ngamiland report that they have been experiencing water insecurity for over 10 years, despite having improved water sources. Water insecurity in gazetted settlements manifests in the form of lack of supply from improved sources for prolonged periods of time ranging from one hour to days or weeks, and at some standpipes even months or years. This also includes supply of poor quality water, which has a bad taste, odor, visible sediments or discoloration. In ungazetted settlements, water insecurity manifests in the form of lack of improved water sources and use of poor quality water.

Water shortages problems experienced in Maun are captured in a petition presented to the Minister of Minerals, Energy and Water Resources on 14 March 2011 by the residents. The petitioners complained to the Minister that the DWA in Maun has failed to reliably supply adequate domestic water to the Village for over 10 years as they experience chronic water shortages which could last for a month and the water being supplied was of poor quality (Residents, 2011). However, no reply came from the Minister responsible regarding this matter.

Sixty percent (60%) of the households across all the settlement categories faced episodes of serious water shortages between 2005 and 2011. Twelve months (i.e. June 2011 and June 2012) preceding the survey, 74% of households across all the settlements experienced extreme water shortages. Thirty-three percent (33%) of the households experienced cut-off in supply within the previous 24 hours preceding the survey and 32% did not have water supply from their main sources at the time of the survey.

All (100%) households from Matlapana and Somelo last had water from their main sources in 2009. Disruptions to water supply to households in Maun Village and Ikoga could last for more than a month.

All households from ungazetted settlements, i.e. Gucha, Samedupi and Xobe, use untreated water accessed from rivers and streams, polluted by wild and domestic animals through their droppings. People who either bath or do laundry at these sources also pollute the water.

4.4 Factors Behind Water Insecurity in Ngamiland

Key informant interviews and FGDs established that Botswana's policy of providing water services to gazetted settlements at the exclusion of ungazetted settlements represents a policy-related factor to water insecurity.

Key informants from the DWA's hydrology section in Maun highlighted that Ngamiland has limited surface water resources as it receives low average annual rainfall of 450 mm. Rainfall is also erratic, and when coupled with high evapo-transpiration rates, there is often little water for domestic use. The environment is also unsuitable for dam construction because of its fragility and the potential high evaporation rates. Water sources for Ikoga, Maun Village, Matlapana and Somelo are either located on floodplains (e.g. boreholes) or on the river banks (e.g. treatment plants) and their operations are negatively affectedby periodic flooding, as they become inaccessible.

Officials from the DWA and the NWDC highlighted that over the years, their organizations have been encountering financial constraints, as they depended on financial resources from central government for water supply services. This negatively affected water supply services as there has been limited investment in water supply, including the operation and maintenance of infrastructure. Moreover, both the DWA and the NWDC supplied water as a social good, with no financial charges, to public standpipes in gazetted settlements, and costs have therefore not been met by the consumers. Population growth and urbanization of Maun have put pressure on the existing infrastructure, which has not been upgraded in more than 30 years.

4.5 Coping Strategies to Water Insecurity

Coping strategies being employed by households in Ngamiland require little planning, and few financial and material resources.

4.5.1 Fetching of Untreated Water

Households from across all settlement categories demonstrate their agency by accessing untreated water from perennial rivers whenever they experience water shortages or when they do not receive any services. There is a strong statistical association between settlements and fetching untreated water by households during times of shortages (Pearson's chi-square test value = 152.029[a], degree of freedom = 7, $p = 0.000$), significant at 5% level.

Households from Maun Village (35%), Matlapana (96%) and Ikoga (93%) access untreated water from nearby perennial rivers.

The Thamalakane (accessed by Maun and Matlapana households) and Boteti (Samedupi and Xobe households) Rivers are generally perennial but sometimes dry up, for example, in the years between 1995 and 2005. During this period, households from Samedupi and Xobe dug unprotected wells in the floodplain to access water for domestic purposes. Ikoga village households access water from Ikoga River while Gucha households access water from Kweenokore stream whenever.

There is a statistical association between settlement category and distance to untreated water sources (Pearson's chi-square test value = 173.313[a], degree of freedom = 36, p = 0.000) significant at 5% level. Untreated water sources are located further away for ungazetted settlements households than the gazetted ones (Figure 4).

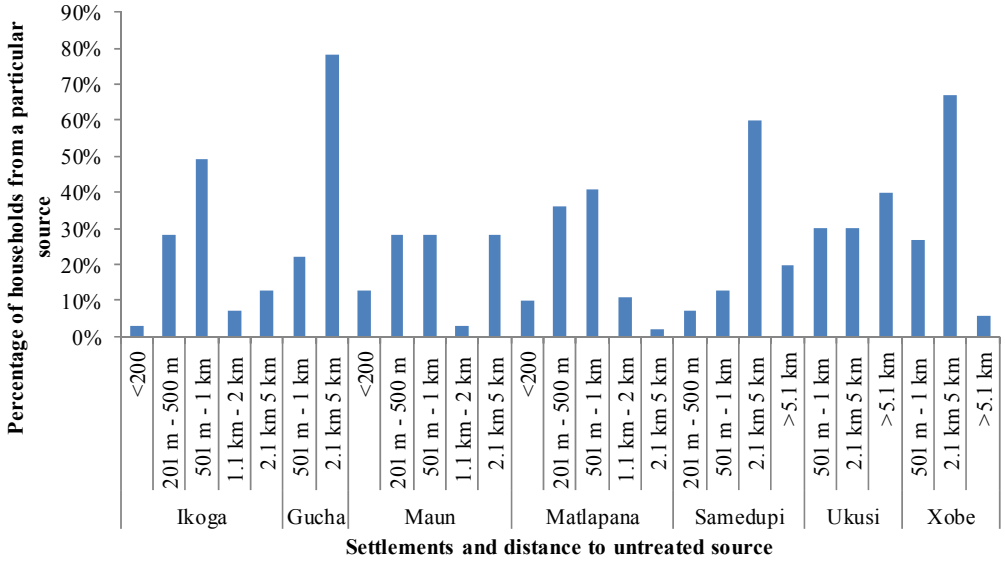

Figure 4. Distance to untreated water sources

Kruskal-Wallis 1-Way ANOVA test show significant differences in terms of distances to water sources between gazetted and ungazetted settlements (Table 5). There are no significant differences in terms of distances to untreated water sources between gazetted settlements.

Table 5. Comparison of distance to untreated water sources between villages – Kruskal-Wallis 1-way ANOVA

Village to village relationship	F - Statistic	Significance level
Matlapana-Maun	13.792	0.263
Matlapana-Ikoga	-16.861	0.175
Matlapana-Xobe	-72.779	0.000**
Matlapana-Gucha	-73.468	0.000**
Matlapana-Samedupi	-77.546	0.000**
Matlapana-Ukusi	-82.179	0.000**
Maun-Ikoga	-3.070	0.831
Maun-Xobe	-58.988	0.002*
Maun-Gucha	-59.676	0.001**
Maun-Samedupi	-63.754	0.001**
Maun-Ukusi	-68.388	0.000**
Ikoga-Xobe	-55.918	0.004*
Ikoga-Gucha	-56.607	0.002*
Ikoga-Samedupi	-60.685	0.002*
Ikoga-Ukusi	-65.318	0.002*
Xobe-Gucha	-0.689	0.975
Xobe-Samedupi	-4.767	0.838
Xobe- Ukusi	-9.400	0.667
Gucha-Samedupi	4.078	0.855
Gucha-Ukusi	8.711	0.675
Samedupi-Ukusi	-4.633	0.832

**Highly significant at $<p=0.001$.

*Significant at $p=0.05$.

4.5.2 Fetching Water From Neighbors' Taps

During times of water shortages, some private properties in Maun and Ikoga continue to have water available from their standpipes. Ikoga village has one such property and the owners allowed their neighbors to fetch water during shortages because cost implications were low, since they paid BWP4.75/month until January 2014. In February 2014, the WUC installed a water meter on the standpipe and the property owners started denying their neighbors access to their standpipe fearing high water charges.

In Maun, some households always have uninterrupted water supply during times of shortages. Such households usually assist those experiencing acute shortages. In most cases those who are assisted are not charged, though some of them are said to be charging BWP5 for each 20 L container.

4.5.3 Sourcing Water With Light Vehicles

Light vehicles are used to source water by 16% (i.e. 14% in Maun and 2% in Matlapana) of households during periods of water shortages from workplaces, DWA offices, and other residential wards. Such households devise other coping strategies when the vehicles used to source water are not available or unable to go and source water. Some households in Maun pay BWP30 for hiring taxis to transport 20 L or 25 L containers.

4.5.4 Bulk Water Market

Due to the prevailing water shortages, a bulk water supply and buying market emerged around 2000 in Maun and Matlapana. Bulk water is bought by households earning BWP5,000 and above and is put in storage tanks ranging in size from 2.5 m^3 to 10 m^3. The suppliers abstract water from Thamalakane River, private boreholes or buy from WUC and then put a mark up. Most of the suppliers abstract water directly from the Thamalakane River

and supply it in its raw state. Transportation is done using ordinary trucks with storage tanks or proper water tankers. The average charges are approximately BWP80/m^3 (BWP150 for 2.5 m^3, BWP300 for 5 m^3 and BWP600 for 10 m^3). Water abstracted from the river is said to be of poor quality by households buying it, since it is supplied untreated. It is also very expensive compared to what WUC charges, i.e. BWP1.50/0-5 m^3 and BWP1.25/0-5 m^3 which households in Matlapana and Maun pay respectively.

4.5.5 Bulk Water Hauling

Service providers (i.e. NWDC and DWA) resorted to bulk water hauling since 2009 using tankers to enable households to cope with water shortages in gazetted settlements (i.e. Maun, Matlapana, Somelo and Ikoga). In Maun, the DWA put in place 10 m^3 plastic storage tanks in 2012 at strategic points in wards where water shortages were experienced. The tanks were filled with water twice a day. However, residents complained that the water hauled was inadequate since it got finished within a short space of time.

Though Matlapana village started experiencing water shortages in 2009, bulk water hauling by the NWDC commenced in October 2012. The VDC and the ward councilor put pressure on NWDC to haul water to the village and six storage tanks of varying sizes, i.e. 5 m^3 and 10 m^3, were put in place at different points. These were filled by a tanker once a day. This prevented households from using untreated water of poor quality from the river. However, the service was stopped when WUC took over water supply and no reasons were given. Households were compelled to resort to fetching untreated water from river again.

Water is hauled to Ikoga village from other sources in the sub-district whenever there is a supply problem. In 2011, the treatment plant was submerged by floods and a tanker hauled water to the village twice a day for three weeks. In January and February 2014, the village had water hauled by a tanker since there was no supply from the treatment plant.

Somelo village, located 70 km from Maun has relied on water hauling since 2009 when its borehole, located on a floodplain 40 km away, was submerged by floods. An NWDC 10 m^3 tanker is supposed to supply the village with water twice daily and WUC has continued water hauling to the village. Households in Somelo have no other coping alternatives since a borehole in the village yields saline water. However, water hauling to the village is unreliable due to constant breakdowns of the tanker, resulting in households going for more than a week without water at times. During such times, households are forced to use saline water for domestic purposes.

4.5.6 Traditional and Improvised Rainwater Harvesting

Sixty-three percent (63%) of the households practicing rainwater harvesting as a way of countering water shortages. There is a strong statistical association between water shortages and the practice of rainwater harvesting, (Pearson's chi-square value = 25.629^a, degree of freedom = 7, p = 0.001) significant at 5% level. Households practicing rainwater harvesting (94%) employ their agency by using open containers, which range in sizes from 20 L to 100 L to collect rainwater from rooftops. The practice is simple because not much investment costs are involved. Households as actors are knowledgeable and capable as they are aware that when they harvest rainwater they are able to reduce trips to the river or to other sources. Several households (66%) in different settlements can harvest more than 200 L from one heavy rainy event. Eighty-nine percent (89%) of those households harvesting water believe that its quality (i.e. in terms of taste and color) is very good.

One percent (1%) of the households in Maun, Matlapana, Somelo and Ikoga have improvised rainwater harvesting systems which enable them to harvest water using storage facilities ranging from 0.210 m^3 - 0.5 m^3 tanks. Water from the rooftops is channeled into polythene or polyvinyl chloride (pvc) pipes into the storage tanks. These storage tanks are usually emptied once they fill up so as to harvest more water from subsequent rainy events.

4.5.7 Water Quality

Microbiology tests for water from the study areas show that the water is below the national standards required for drinking water as specifications for drinking water for Botswana state that the presence of any pathogens renders water unacceptable (Botswana Bureau of Standards, 2009). Water samples from private standpipes in Matlapana, Ikoga and Somelo show high counts of total coliforms while counts for the other parameters, i.e. faecal coliforms and streptococci are relatively low except for Matlapana and Somelo respectively (Figure 5).

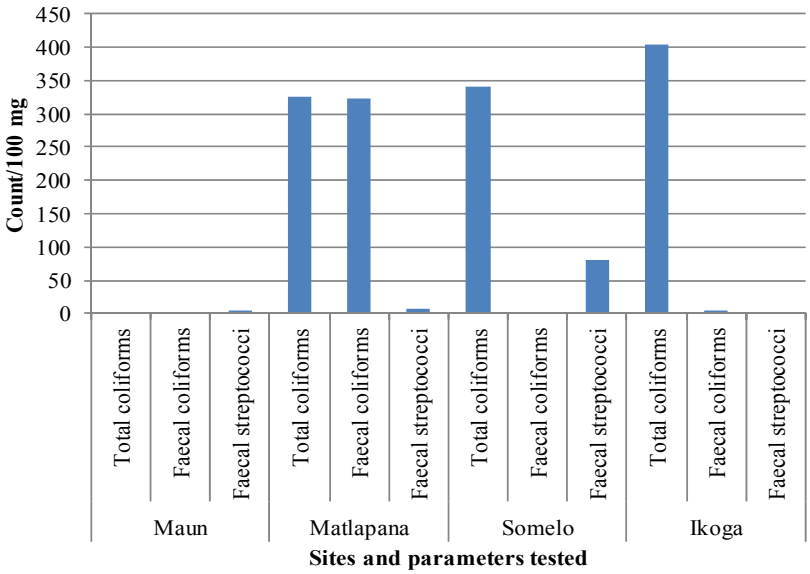

Figure 5. Water quality results for private standpipes

Water quality results from public standpipes from Ukusi village shows high levels of total and faecal coliforms while results Somelo shows unacceptable high levels of total coliforms (Figure 6).

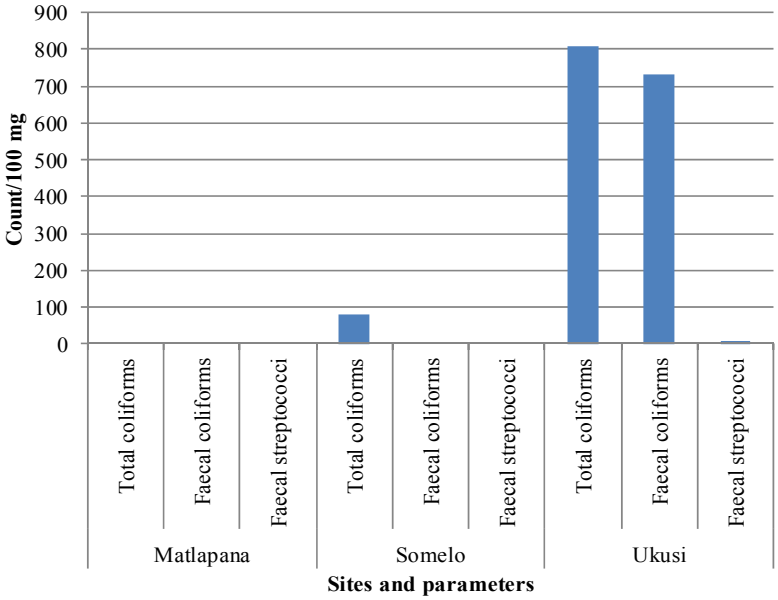

Figure 6. Water quality results for public standpipes

Water from untreated sources shows unacceptable levels of all microbiology parameters (Figure 7).

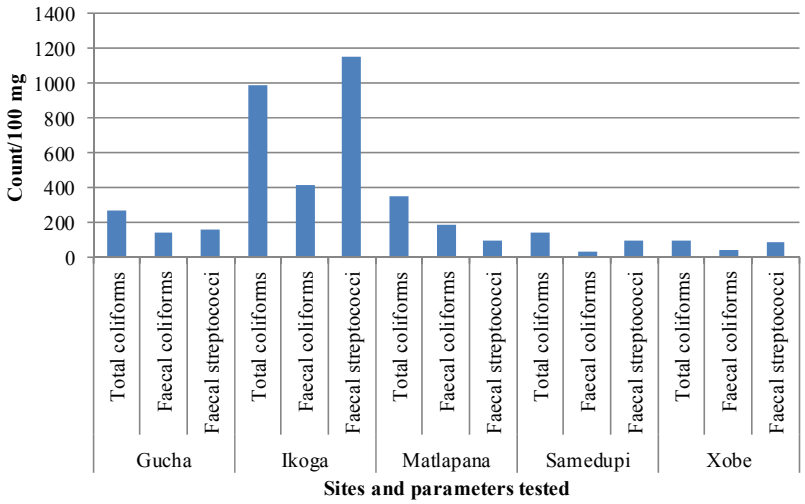

Figure 7. Water quality results for untreated water sources

Water quality from rainwater harvesting tanks from Ikoga and Matlapana and from a borehole in Somelo, show that the water has some unacceptable microbiology counts (Figure 8).

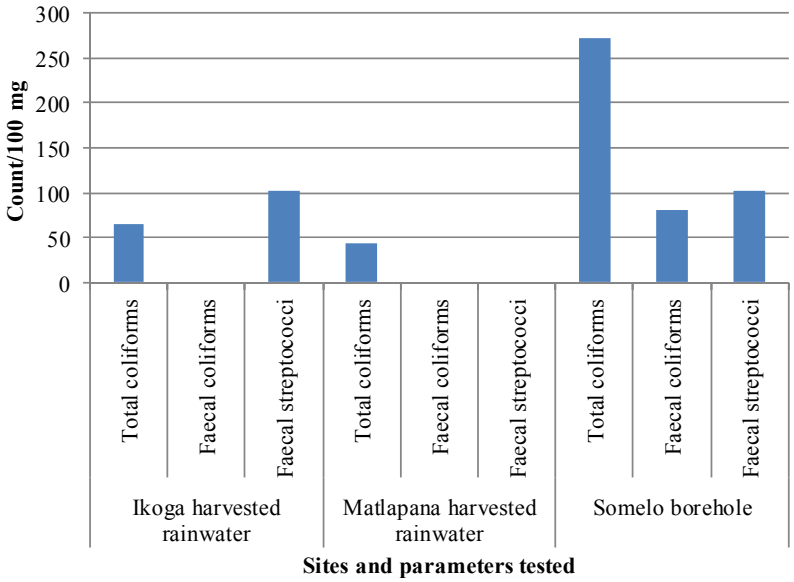

Figure 8. Water quality results for rainwater tanks and borehole water

Despite evidence that water from several sources is of unacceptable quality for drinking, 55% of households from gazetted settlements are satisfied with the quality of water from their main sources. Forty-five percent (45%) of the households view water from their main sources as being of poor quality because it is discolored, smells unpleasantly and has visible sediments.

Households from Gucha (85%), Xobe (80%) and Samedupi (63%) confirmed the water quality results presented in Figure 7 as they complained that the water from their sources is muddy and discolored as a result of pollution caused by domestic and wild animals. Some household members sometimes contract waterborne diseases such as diarrhea.

Across all the settlements, where there is evidence of poor water quality, 90% of the households do not treat their water to make it safer to drink. Households from Samedupi (80%), Xobe (90%), Gucha (90%), Matlapana (70%), Maun (92%) and Somelo (100%) drink the water from the unprotected sources without boiling.

4.5.8 Prioritizing Water Use for Different Activities

During times of water shortages, all households (100%) across the different settlement categories ranked water uses, starting with the most important use as follows: cooking (100%), drinking (100%), bathing (98%). Other water use activities such as laundry and general cleaning become peripheral during such times.

Bathing in 72% of the households is determined by water availability. When there is less water, household members either have to reduce the frequency of bathing per day or the amount of water used, or do not bath at all. In Somelo, household members can go for 5 or more days without taking proper baths.

Laundry is usually done fortnightly by the majority (72%) of the households when water is scarce. Households members from settlements located closer to rivers, wash their laundry there. In Somelo, households have either to wait for the water tanker or use saline water to do laundry.

4.5.9 Storing Water in Containers

The majority (97%) of households across the different settlement categories store water in containers, i.e. 20 L or 25 L for current and future use. These containers are preferred for storing water mainly because they are easily accessible and can also be carried by adult household members from different water sources to the homestead. The average number of containers owned by different households across the different settlement categories is 6. In Somelo, the average number of 20 L containers owned by each household is 11.

4.5.10 Buying Bottled Water

Fourteen percent (14%) (12% from Maun and 2% from Matlapana) of the households purchase bottled water for drinking. The water is mainly purchased by households with monthly incomes of at least BWP1 000. An average of 15 L is purchased every week by each household, at a cost of BWP45. Sixty-one percent (61%) of the households, purchase bottled water because it is safer to drink while 29% do so because it is readily available and 10% do not trust the quality of water from other sources.

4.6 Adaptation Strategies

A few households have been able to adapt to water shortages through various strategies to ensure uninterrupted water availability for household use. Adaptation strategies are mostly implemented by households earning at least BWP10,000 per month.

4.6.1 Boreholes and Well Points

Two percent (2%) of households from Maun and Matlapana have been able to drill their own boreholes and well points along the Thamalakane River floodplain or riverbed, equipped with electric pumps and motors. Fresh groundwater resources are only available in floodplains as it is saline in other locations. Some of the households have been pumping groundwater for over twenty years. Major costs involved are the initial investment (e.g. BWP8,000) and running costs especially electricity (e.g. BWP500 per month or more). All households with boreholes or well points have storage tanks of between 2.5 $m^3$and 10 m^3into which water is pumped.

4.6.2 Rainwater Harvesting

Five percent (5%) of the households (i.e. 3.4% in Maun, 1.2% in Matlapana and 0.4% in Somelo) practice rainwater harvesting using proper rooftop gutters which channel water into storage tanks of different sizes, i.e., 2.5 m^3 to 10 m^3. The harvested water usually lasts up to the following rainy season from around March as it is only used when there is no water from the main sources.

4.6.3 Connecting Storage Tanks to the Main Water System

Direct observation in Matlapana and Maun revealed that some of the households have connected storage water tanks of varying sizes, i.e. 2.5 m^3 to 10 m^3, to their main water systems. A minimum of BWP6,000 is spent on such connections. Informal interviews with members from such households indicated that the main water systems are meant to fill up the tanks when water is available for use in times of shortages. Households in Wenela ward with such connections, can access water from the tanks for more than a month if there is a shortage. Water supply to the ward is intermittently cut, and as a result, the households are able to deal with the regular water shortages.

7. Discussion

Data presented in this paper demonstrates that water insecurity is a challenge for households in different settlement categories of Ngamiland, Botswana as they experience water supply and quality challenges. The presented results are consistent with those of other studies in Ngamiland (Kgomotso & Swatuk, 2006; Mazvimavi & Mmopelwa, 2006; Ngwenya & Kgathi, 2003). The phenomenon is not unique to Botswana as it is

common in other developing world countries such as Ethiopia, South Africa, Tanzania and Zimbabwe where households go for prolonged periods of time without any supply or have water of poor quality supplied to them (Manzungu et al., 2012; Penrose, de Castro, Werema, & Ryan, 2010; Pritchard, Mkandawire, & O'neill, 2007).

Households in gazetted settlements go for prolonged periods of time without water despite the fact that they have improved water sources while households from ungazetted settlements do not receive any water supply services. Water insecurity is experienced by households in Ngamiland despite the fact that Botswana is one of the few sub-Saharan African countries with 97% of the population with access to improved water sources (WHO, 2013). Access to improved water sources is closely associated with reasonable access to an adequate amount of water from a source such as a household connection, public standpipe, borehole, protected well or spring, and rainwater collection (WHO/UNICEF, 2013; World Health Organisation, 2013). There are currently no mechanisms in place to monitor reliable water availability from improved water sources. As a result, the mere presence of such a water source is usually taken to represent water availability for households (WHO/UNICEF, 2013). Households with access to such sources can go for prolonged periods of time without water supply (Kujinga, Vanderpost, Mmopelwa, & Wolski, 2013). Using the presence of improved water sources to define access to water, usually does not take into consideration the quality of the water. As shown by the results from Ngamiland, water quality across the different settlement categories is unsuitable for drinking regardless of where it is drawn from. Water security, which takes into consideration access, quantity, quality, availability and affordability of water could be a better measure for access to water.

The use of an actor oriented approach in this paper helped to understand water insecurity at the local level in lifeworlds where it is assumed that there is water security. Despite the fact that eighty-eighty percent (88%) of the households in Ngamiland district have access to improved water sources (presuming security), water insecurity is still a major challenge to many households in Ngamiland. The approach also allowed analysis of how actors cope and adapt to water insecurity in their lifeworlds through their own agency. Consistent with findings from other studies, households in Ngamiland are not homogenous but heterogeneous regarding the strategies that they implement in coping and adapting to water insecurity (Long & Villarreal, 1994).

Households facing water insecurity in developing countries tend to employ autonomous coping strategies (Adeniji-Oloukoi et al., 2013). Coping strategies such as bulk water buying, traditional rainwater harvesting and prioritization of water use, are common in other developing world countries such as Zimbabwe, Tanzania, Nigeria, Sudan and Kenya (Adeniji-Oloukoi et al., 2013; Manzungu & Chioreso, 2012; Manzungu et al., 2012; Opryszko, Huang, Soderlund, & Schwab, 2009). Though households are able to show their agency in a lifeworld of water insecurity, this agency is mainly limited to autonomous coping for the majority, as they fetch water from untreated sources or use other unsustainable methods such as use prioritization, fetching water from neighbours with running water and relying on bulk water hauling by service providers.

The ability of households to cope with water insecurity depends on the socio-economic status of the household as relatively high income households invest in strategies that are more long-term compared to low income households. Few households are able to adapt to water insecurity mainly by having their own water supply sources such as boreholes or effective rainwater harvesting systems (Manzungu & Chioreso, 2012).

It is imperative for governments where water insecurity is experienced to adopt planned intervention approaches (Long & van der Ploeg, 1989) by formulating policies and implementing strategies that enhance water security based on research. Water policies, strategies, financial investments under the Water for Good Plan for South Australia were informed by research and this enabled the state to achieve water security (Government of South Australia, 2008). Strategies to deal with water insecurity need to be divided into short, medium and long term for effective implementation. In the context of Botswana, water policies and strategies have to focus on all the different settlement categories including ungazetted settlements. Botswana's vision 2016 recognizes the importance of access to safe and clean water to all settlements (Presidential Task Force Group, 1997). Water supply to some ungazetted settlements by the Okavango Sub-district Authority shows that with proper planning, the service can be extended to more such settlements.

In the short-term, water hauling can be done as a stop gap measure to gazetted settlements facing water shortages. To improve water quality, there is need for training and awareness programmes among households on different water treatment methods (e.g. straining, boiling, chemical disinfection, solar disinfection) which can be used at the household level (IFRCS, 2008; UNICEF, 2008). Households need to be made aware that access to water from an improved source does not mean that it is safe for drinking as demonstrated in the paper. Treating water at the household level is an effective and cost-effective means of preventing waterborne diseases and it allows households to play a role in enhancing water security (UNICEF, 2008).

Rainwater harvesting constitutes a short-term strategy which households in Ngamiland can be encouraged to embark on. However, research has to inform the type of infrastructure that can be used as well as strategies for encouraging uptake by households. Rainwater harvesting from rooftops is simple, cost-effective and on-site supply of water to the household with little treatment (Garrison, Kloss, & Beckman, 2011). It reduces strain on existing water supply sources. Incentives such as tax rebates, subsidized equipment, e.g. storage tanks and other collection materials can be offered in order to encourage uptake. Australian states such as South Australia and the Australian Capital Territory have laws requiring private property owners to install at least a 5 m^3 tank for rainwater harvesting purposes (Government of South Australia, 2008).

Mid-term strategies underpinned by research could focus on Maun Village for the implementation of strategies such as stormwater harvesting and wastewater recycling. Stormwater can be harvested from storm drains around the Village before being purified and used for non-drinking purposes like it is done in Australia (Sidney-Water, 2013). Wastewater recycling will involve removing solids and certain impurities and then use the water for toilet flushing, laundry, fire fighting, building construction, car wash and industrial machine and plant cleaning (Sydney Water, 2012). This helps in reserving purified water for drinking and cooking. The city of Sydney in Australia does water recycling with a considerable degree of success and it projects to recycle 70 billion liters of water per year (i.e. 12% of Sydney's needs) by 2015 (Sydney Water, 2012).

Long term strategy for achieving water security for Botswana would be to ensure that all settlement across the different settlement categories receive clean water supply services reliably and sustainably as enshrined in the Vision 2016 (Presidential Task Force Group, 1997). It is important that the already existing water supply infrastructure in gazetted settlements provides water on a reliable basis. Research aimed at influencing policy and planning can focus on the possibilities of establishing solar powered village water treatment plants in scattered ungazetted settlements and villages like Somelo. Such treatments plants can be operated and maintained by trained villagers.

Strategies identified above will have to be informed by research and underpinned by policy, legislation, a sound financial package, appropriate technologies and political will. It is imperative for the international community through organizations such as the World Bank, International Monetary Fund and the African Development bank to advance financial packages for the enhancement of water security in countries like Botswana. Developed countries which have been able to achieve a higher degree of water security went through a process which involved refining their water supply policies, committing financial resources to the provision of clean water and investing in appropriate technologies for water supply (UNDP, 2006). Such an approach will go a long way in assisting households in different settlement categories of Ngamiland from adopting unsustainable coping strategies to water insecurity.

8. Conclusion

The majority of developing countries including those classified as middle income, are facing water insecurity. Botswana in general and Ngamiland in particular, is also experiencing this phenomenon. This is despite the fact official statistics highlight that 97% of the population has reliable access to water through improved sources. In the context of water insecurity in Ngamiland, households are mainly compelled to use autonomous coping strategies that are unsustainable, such as getting untreated water, making them vulnerable to waterborne diseases. A few economically better off households are able to adopt adaptation strategies that are long-term, reducing their vulnerability to risks associated with water insecurity.

The state through the Water Utilities has to adopt more effective planned intervention approaches that will enhance household water security in different settlement categories. This can be done through the formulation of policies and strategies (i.e. short, medium and long term) for water security underpinned by research. Water policy has to emphasize on the implementation of different strategies aimed at achieving household water security such as rainwater harvesting, stormwater harvesting and wastewater recycling. Moreover, water security which takes into consideration issues of access, quality, quantity, availability and affordability need to be adopted as an appropriate measure for access to water as opposed to the mere presence of improved sources.

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Endnotes

[1]USD1 = BWP8.83

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CHAPTER FIVE

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Analysis of Gender and Other Social Dimensions of Household Water Insecurity in Ngamiland, Botswana

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Abstract

This paper analyzes impacts of water insecurity on men, women and children in Botswana, a middle income and semi-arid country. The paper contributes to the burgeoning literature on water security. Households in different settlement categories of Ngamiland, Botswana experience water insecurity. Men, women, girls and children living in water insecurity lifeworlds, play various roles in ensuring household water availability. Women and girls have the greatest agency in ensuring household water availability by spending considerable time transporting water containers loaded on their heads and engaging in rainwater harvesting. Water insecurity negatively affects personal hygiene and gives rise to household interpersonal conflicts. Countries facing water insecurity, e.g. Botswana need to promote research that can inform appropriate water policies, legal frameworks, technologies for water supply and financial mechanisms for enhancing household water security.

Keywords: actors, Botswana, gender, social, water security

1. Introduction

A global water crisis unfolded in the last century as a result of rapid economic development, population growth, urbanization and climate change and variability (Bogardi et al., 2012; Hoff, 2009). While developed countries have been able to put in place measures (i.e., policies, institutions, financial mechanisms and technologies) that help to ensure water security (Grey & Sadoff, 2007; UNDP, 2006); almost all developing countries are being negatively affected by the global water crisis (Lougheed, 2013). This has led to an imbalance in daily water availability per capita for citizens of developed countries, for example: 151 L/day for a citizen of the United States of America (USA); whilst the per capita use for developing countries is 5 L/day (UNDP, 2006). As a result, the 1.1 billion of people lacking adequate clean water are from developing countries (Chamberlain, 2008).

Drinking or use of unsafe water kills an estimated 1.6 million children annually mainly from developing countries as a result of waterborne diseases (Lougheed, 2013). In order to reduce the number of people who die due to lack of access to clean water, the Millennium Development Goal (MDG) 7, target 10 aims at halving the proportion of people without reliable access to safe drinking water and basic sanitation by 2015 (UN, 2013). Access to clean water, in this context, means that the improved source (i.e. household connection, public standpipe, borehole, protected dug well, protected spring or rainwater) is less than 1 km away from its place of use and that it is possible to reliably obtain at least 20 L per member of the household per day (WHO, 2013). While households in some African countries have improved water sources, they do not always have access to water from such sources (UN, 2013). This forces such households to resort to using untreated water sources (Kujinga, Vanderpost, Mmopelwa, & Wolski, 2014; Manzungu & Chioreso, 2012a; Manzungu, Mangwanya, & Dzingirai, 2012). This has been the case even in countries classified as middle income (e.g., Botswana, South Africa and Jordan) (UNDP, 2013). In Botswana, statistics suggest that 97% of the population has access to clean water through improved sources (Jefferies & Kenewondo, 2013). This figure however, only considers the presence of improved sources and does not consider reliability of water supply. These statistics mask the contradictory reality associated with access to water as it is in real life (Kgomotso & Swatuk, 2006). It therefore becomes imperative to understand these realities empirically.

Women, girls and children in developing countries constitute two thirds of the millions of people who currently struggle on a daily basis to locate and transport water for drinking, cooking and washing needs (Lougheed, 2013). In sub-Saharan Africa, e.g., women spend 40 billion hours per year collecting water and therefore have less time to fulfill all their domestic responsibilities, engage in money-making activities, participate in politics or other public activities, attend school, acquire other skills, or simply rest (UNFPA, 2009). Girls are sometimes kept home from school to help fetch water, thereby perpetuating the cycle of disempowerment. The high prevalence of diseases such as malaria, HIV and AIDS in Africa, increases the burden on women as they are the ones who have to fetch water for the sick (Omari, 2010).

This paper analyzes impacts of water insecurity in Botswana, a middle income and semi-arid country. The analysis focuses on gender i.e. women and girls who physically bear the brunt of water insecurity through spending prolonged periods of time fetching water which they carry in containers loaded on their heads. In addition there are other social dimensions: use of various assets, rainwater harvesting, personal hygiene and the inter-personal politics of fetching water from neighbour's standpipes. The paper also contributes to literature on water security and hopes to influence the development of policies and strategies which enhance water security by governments of developing countries such as Botswana.

2. Analytical Framework

Gender and other social dimensions of water insecurity experienced by households in various settlement categories of Ngamiland are analysed using the actor-oriented approach (Long, 1988, 1992; Long & van der Ploeg, 1989b; Long & Van der Ploeg, 1994) and the concept of water security (Cook & Bakker, 2012; Grey & Sadoff, 2007; GWP, 2000; Lautze & Manthrithilake, 2012; Vörösmarty et al., 2010). 'Security' here refers to freedom or protection from serious risks and any threats to human well-being (Soroos, 1994). Water security thus, entails protection from the risk of water shortages, waterborne disease due to poor water quality and death. Water security refers to the availability of, and access to water in sufficient quantity and quality to meet livelihood needs of all households throughout the year (GWP, 2000). Water insecurity refers to unavailability and inaccessibility of enough water of good quality to meet households' domestic, productive and environmental needs (Webb & Iskandarani, 1998).

The entry point in an actor-oriented analysis, is the social actor which is a social and cultural construction referring to individuals, households, groups and institutions (i.e. government ministries and departments, water supply institutions and NGOs) performing an action (Magadlela, 2000). In the scenario of this paper, social actors are households, and individuals within households, who are negatively affected by water insecurity and who take active roles in ensuring household water availability. The analysis of gender and associated social dimensions of household water insecurity, using the actor-oriented approach, facilitates the identification of the involved actors, their interests, objectives and organising strategies (Magadlela, 2000). A 'household' refers to a social institution of two or more people (not necessarily permanent), whose primary feature is co-residence, eating and pooling of resources together with their involvement in the provision of essential resources required for a living (Beall & Kanji, 1999; Rakodi, 1991; UN, 1976).

The reality of water insecurity enters the lifeworld of actors (Long, 1990b). A 'lifeworld' refers to how the actors in a particular physical, social, political and economic context view themselves and their situation, their everyday lives and encompasses how they view the outside world and interpret new innovations using the conceptual tools acquired in their own world view (Long, 1990a; Magadlela, 2000). A lifeworld includes: gender roles, social relations and expectations (in this instance: for women to fetch water for household use).

Where households face water shortages and unavailability, women and men have the agency to take an active role in ensuring household water availability by going to other sources using various types of household assets. This is 'human agency', which attributes to the actor/s the capacity to process social experience and to devise ways of coping with life, even under difficult conditions (Long, 1992). Household members may take active roles in enhancing household water availability during shortages. This paper analyses the agency of men and women in Ngamiland as they strive to ensure household water availability in the context of water insecurity. It also identifies limitations to their agency.

Adult men and women and children from the same or different households can adopt heterogeneous strategies for ensuring household water availability. The concept of heterogeneity helps to analyse the numerous strategies adopted by men and women within the same or different households and settlements in order to ensure water availability at the household level (Long & Villarreal, 1994). The responses of actors may differ even when they are exposed to similar situations, as in the conditions that appear to be relatively homogenous such as those influenced by water insecurity (Long, 1990a). Responses of the actors will be as a result of the assets, income

and networks they have.

In the process of endeavoring to ensure household water security, individual actors from different households can create beneficial networks based on other actor's assets. For example, negotiating the use of donkey drawn carts or vehicles used to fetch water. Any network is a more or less homogenous set of ties between and among actors. These networks, are not always horizontal or balanced, a network may be asymmetrical, unbalanced and is sometimes more like client-patron relations (Tilly, 1995).

3. Materials and Methods

3.1 Study area

The study sites are located in the North-West District (also known as Ngamiland) of Botswana (Figure 1) which has a population of 158,104 (Central Statistical Office, 2011a). The district is under the administration of the North West District Council (NWDC) which is sub-divided into Maun and Okavango sub-district authorities, administered from Maun and Gumare respectively. The district's main administrative center is Maun Village which has a population of 60,263 (Central Statistical Office, 2011a).

The Okavango River is part of a river basin shared by Angola, Botswana and Namibia, and is the main physical feature in the district (Figure 1). This Okavango River in Botswana forms a large, delta-like feature (actually an alluvial fan) which is a World Heritage site, known as the Okavango Delta (McCarthy & Ellery, 1998).

Tourism and livestock rearing are the main commercial activities in the district (Motsholapheko, Kgathi, & Vanderpost, 2010). Ngamiland has a poverty rate of 37.6% as opposed to the national rate of 20.7% and 15.3% of the economically active population is unemployed (African Economic Outlook, 2013; Central Statistical Office, 2011b, 2011c). The high poverty and unemployment levels in the district do not sit well with the classification of Botswana as an upper middle income country (UNDP, 2013). In addition the district had an HIV and AIDS prevalence of 27.3% in 2007 (MFDP, 2007).

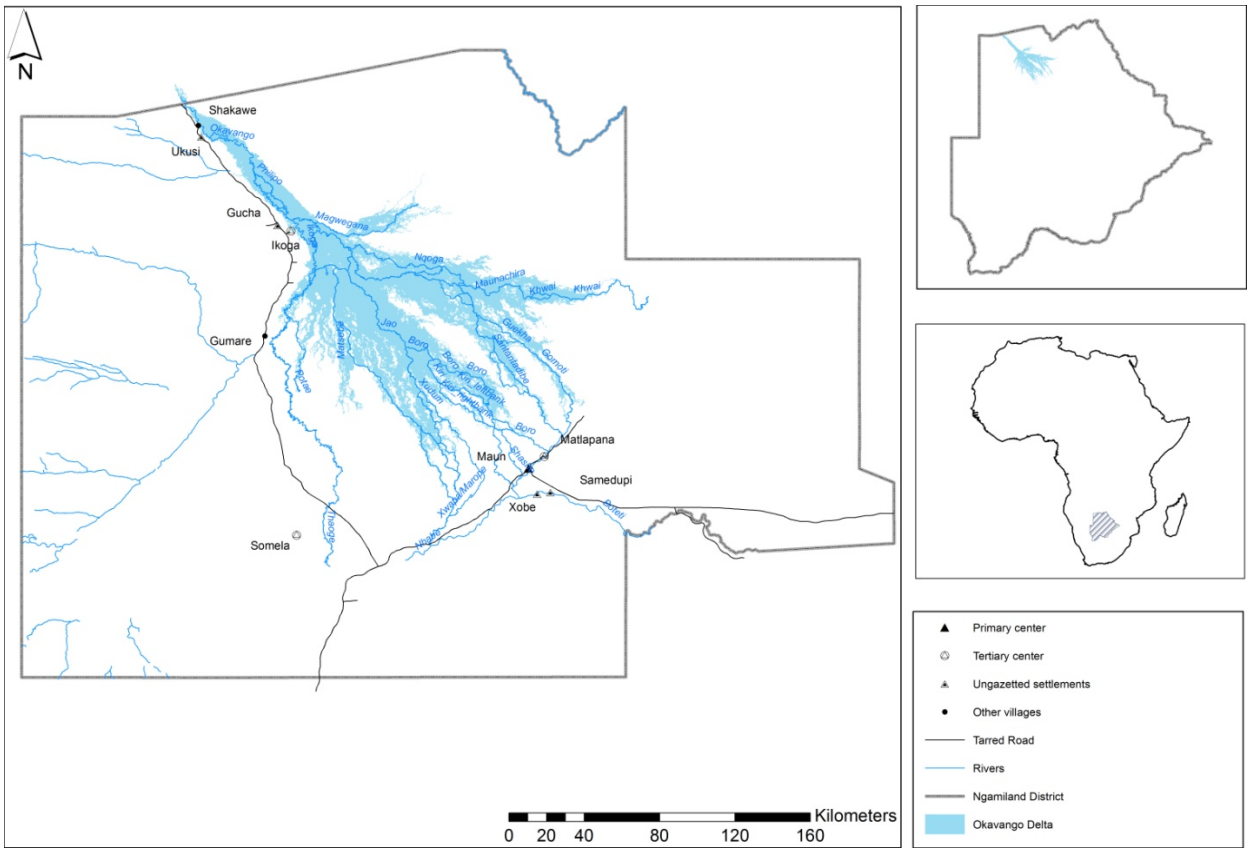

Figure 1. Study sites in Ngamiland District

The study was undertaken in gazetted and ungazetted settlements of Ngamiland (Government of Botswana,

2009). Gazetted settlements are formal settlements which receive services such as water supply, roads, schools, health and police. Entitlement to the provision of these services is based on population size, economic potential, employment generation, natural resources availability such as water for sustaining the settlement (Government of Botswana, 1998). Three levels make up gazetted settlements, i.e. primary, secondary and tertiary centers (Government of Botswana, 1998).

Primary centers have a minimum population size of 20,000, with a high development potential, a sound industrial base to serve as national market centers and high order infrastructure services (Government of Botswana, 1998). These are subdivided into I, II and III. Primary centers I, are cities (e.g. Gaborone) with a population of at least 100,000. Primary centers II, have a population range of 50,000 – 99,999 and primary centers III, have a population range of 20,000 – 49,999 and are referred to as large Villages: e.g. Maun Village in Ngamiland.

Secondary centers have a population range of 10,000-19,999 and may have a weak economic base but play a key role as district or sub-district headquarters such as Gumare (Government of Botswana, 1998).

Tertiary center settlements (sub-divided into I – IV) have population ranging from 250 – 9,999 (Government of Botswana, 1998). These have the following population ranges:

Tertiary centers I, 5,000 – 9,999.

Tertiary centers II, 1,000 – 4,999.

Tertiary centers III, 500 - 999.

Tertiary centers IV, 250 – 499.

Ngamiland does not have any category I tertiary centers, only categories II – IV are found in the district.

Ungazetted settlements are informal with population of less than 250 people. They do not have legal entitlement to vital social services delivery (Kgomotso & Swatuk, 2006).

3.2 Water Supply Services

The Water Utilities Corporation (WUC), Department of Water Affairs (DWA) and District Councils (DCs) were responsible for domestic water supply in Botswana until the 31st of March 2013. WUC supplied water to urban centers, DWA to major villages and DCs to small/medium rural villages (Swatuk & Kgomotso, 2007). This arrangement created poor coordination amongst the institutions involved (Government of Botswana, 2009). Under the water sector reforms, which commenced in 2009, WUC supplies and distributes water to all settlements in Botswana. The WUC took over water supply and distribution to all settlements in Ngamiland on the 1st of April 2013.

3.3 Data Collection Methods

Data were collected using qualitative and quantitative methods between February 2012 and March 2014. Qualitative methods gathered data on meanings, opinions, feelings and perceptions regarding gender and other social dimensions of water insecurity. These were not experimentally examined or measured in terms of quantity, amount, intensity or frequency (Neuman, 2000; Schwandt, 1994). Qualitative methods enabled the researchers to interact closely with the actors, i.e. households, men, women and children from settlements affected by water insecurity. The methods used include key informant interviews, participant observation, unstructured/informal interviews and focus group discussions (FGDs). Key informants included village development committee members, ward councilors, traditional leaders and relevant officials from the WUC, NWDC and DWA. The FGDs were conducted with ordinary community members. Participant observation was done in all the settlements where one of the researchers spent some time. The researcher resided in Matlapana for three years, a settlement affected by water shortages. Qualitative data collected include factors behind water insecurity, household responses to water insecurity, fetching of water by gender during periods of water insecurity, assets used to fetch water, rainwater harvesting practice, bulk water supply and water conflicts.

Quantitative data collection was carried out through the use of a structured household questionnaire between May and August 2012. This was used to collect information on general household characteristics i.e. gender and age of households heads, number of household members and income, household water sources, amount of water used for a variety of activities and at different times (i.e. day, month and year), extent of water insecurity in each settlement, how water insecurity impact on men, women and children and assets used to fetch water during periods of water insecurity.

3.4 Sampling

The study was undertaken in 8 purposively sampled sites. The settlements were purposively sampled for various reasons (Table 1).

Table 1. Purposively sampled settlements

Settlement	Settlement category	Location in relation to Maun Village	Reasons for purposive sampling
Maun Village	Primary center III		The only primary center settlement in Ngamiland where water insecurity has been experienced by households for years.
Matlapana	Tertiary center II	10 km NE of Maun	A settlement where water insecurity has been experienced by households for a number of years. Purposively sampled because one of the researchers lived in this settlement for 3 years undertaking participatory observation.
Ikoga	Tertiary center III	315 km NW of Maun	Sampled to understand water insecurity in a gazetted settlement that gets water supply from a surface water treatment plant.
Somelo	Tertiary canter IV	70 km SW of Maun	A gazetted settlement which last received reliable water supply services in 2009 when its source located almost 40 km was submerged by floods. Groundwater resources in the settlement are saline and therefore unfit for domestic use.
Gucha	Ungazetted	320 km NW of Maun	A settlement that has a water supply transmission line passing through it but not receiving water supply services. Households are located further away from perennial water sources.
Ukusi	Ungazetted	370 km NW of Maun	A settlement receiving water supply services despite its status.
Samedupi	Ungazetted	15-20 km S of Maun	Settlements located close to a perennial surface water source. Situated close to Maun, but do not receive water supply services because of their status.
Xobe	Ungazetted		

A 30% household sample size in all the settlements was adopted (see Table 2) using population information obtained from the Central Statistics Office, NWDC and local village leadership. Households in each settlement were listed and each (household) was assigned a number and a random number generator selected households for the survey. Trained enumerators administered questionnaires to household members from the age of 15. Sixty-two percent (62%) of the respondents were women with information on household water issues. A total of 554 questionnaires were administered.

Table 2. Sample sizes by settlement

Settlement	Settlement category	Population size (2011)	Total number of households listed	Number of households sampled
Maun	Primary Center III	4,105[1]	933	295
Matlapana	Tertiary center II	1,449	329	99
Ikoga	Tertiary center III	673	153	46
Somelo	Tertiary center IV	600	41	41
Gucha	Ungazetted	88	20	20
Samedupi	Ungazetted	286	65	20
Ukusi	Ungazetted	261	60	19
Xobe	Ungazetted	260	60	20
Total		7,722	1571	554

[1] This is the population of Boyei and Wenela wards.

Participants for FGDs were randomly picked from male and female headed households from different areas of each settlement. At least one FGD was held in each study settlement and attended by at least 16 participants.

Key informants were purposively sampled from DWA, WUC, NWDC and from community leaders such as councilors, traditional chiefs and village development committees.

3.5 Data Analysis

Quantitative data collected through the use of a structured household survey questionnaire were analyzed using the Statistical Package for Social Sciences (SPSS) version 21. Variables which include settlement category, settlement, household, income and main sources of water and gender were used as independent variables in the analysis. Kruskal-Wallis 1-way ANOVA, a non-parametric test was used in the analysis since the data were not normally distributed. The test was used to determine differences between attributes of non-parametric variables. The Pearson's chi-square test was used to determine association between variables, which include monthly income and settlement, settlement and type of main water sources, water insecurity and sourcing of untreated water, water insecurity and use of different assets, water insecurity and fetching of water by either men or women, water insecurity and the practice of rainwater harvesting by gender and water insecurity and inter-personal conflicts over water within households.

Data from FGDs, key informant interviews and participant observation were categorized into broad themes of socio-economic background of households, water sources, household water insecurity, responses to water insecurity by gender and social relationships during times of water insecurity.

4. Results and Analysis

4.1 Socio-Economic Background of Households

Fifty-three percent (53%) of the households across all the study settlements are female headed while 47% are male headed. The average household size across all the studied settlements is 5.9 as opposed to 4.4 for Ngamiland District (Central Statistical Office, 2011a). There is no statistical association between gender of household head and size. Each household uses an average of 69 liters (or 11.6 L per person) of water per day during periods of water insecurity security while an average of 250 L (or 56 L per person) is used when it is readily available.

In terms of monthly household income, there is a statistical association between settlement and income (Pearson's chi-square = degrees of freedom = 35, p=0.000), significant at 5% level. Gazetted settlements (e.g. Maun and Matlapana) households have relatively higher incomes compared to ungazetted settlements which have lower monthly incomes (Figure 2). However, there is no statistical association between gender of household head and income.

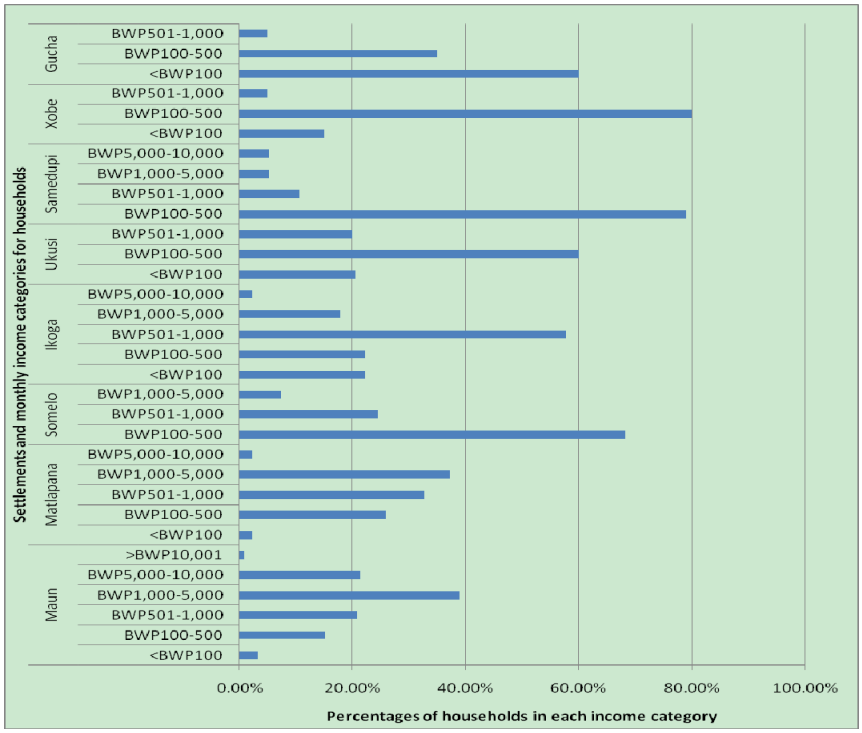

Figure 2. Household income (Note 1)

The generally low incomes in the district is in stark contrast to the classification of Botswana as an upper middle income country whose per capita income is pegged at USD13,102 (UNDP, 2013).

Some of the households possess assets such as vehicles and donkey drawn carts used for fetching water. There are statistical differences between the various settlements in terms of ownership of light vehicles used for fetching water (Kruskal-Wallis 1_way ANOVA test = p=0.000, significant at 5% level). Nine percent (9%) of the households have access to vehicles from other households. Twenty-six percent (26%) of households across all the settlement categories own motor vehicles. In terms of ownership of donkey drawn carts, 16% of households own these assets while 17% have access to donkey drawn carts owned by other households.

4.2 Government of Botswana's role in Household Water Supply

Botswana has improved water sources coverage for 97% of the population (UNICEF/WHO, 2008). Successive governments of Botswana have pursued policies of planned intervention by installing improved water sources in gazetted settlements (Long & Villarreal, 1994). Women and girls at FGDs from gazetted settlements, emphasized that whenever water supply is available, they do not have to walk longer distances to fetch water.

Eighty-eight percent (88%) of Ngamiland's gazetted settlement households access water from improved sources whenever supply is available (Figure 2). There is a statistical association between settlement category and type of main water sources used by households (Pearson's chi-square = degrees of freedom = 42, p=0.000), significant at 5% level. Improved water sources in gazetted villages include: public standpipes (23.1%), standpipes in yard outside the house (46.8%), standpipes inside the house (10.8%) and neighbour's standpipes (7.2%) (Figure 3). Households accessing water from untreated sources (12%) are mainly from ungazetted villages.

The Okavango Sub-district Authority supplied water to 20 ungazetted villages (e.g. Ukusi) located along water transmission lines. Political leadership in the area pressurized the sub-district authority in the 1990s to do so, since their connection did not involve much financial investments. After the connection of the 20 ungazetted settlements, more such settlements (e.g. Gucha) mushroomed along water transmission lines anticipating water supply. This prompted the sub-district authority to stop connecting such settlements for water supply to discourage their mushrooming. The WUC has continued supplying the 20 ungazetted settlements with water.

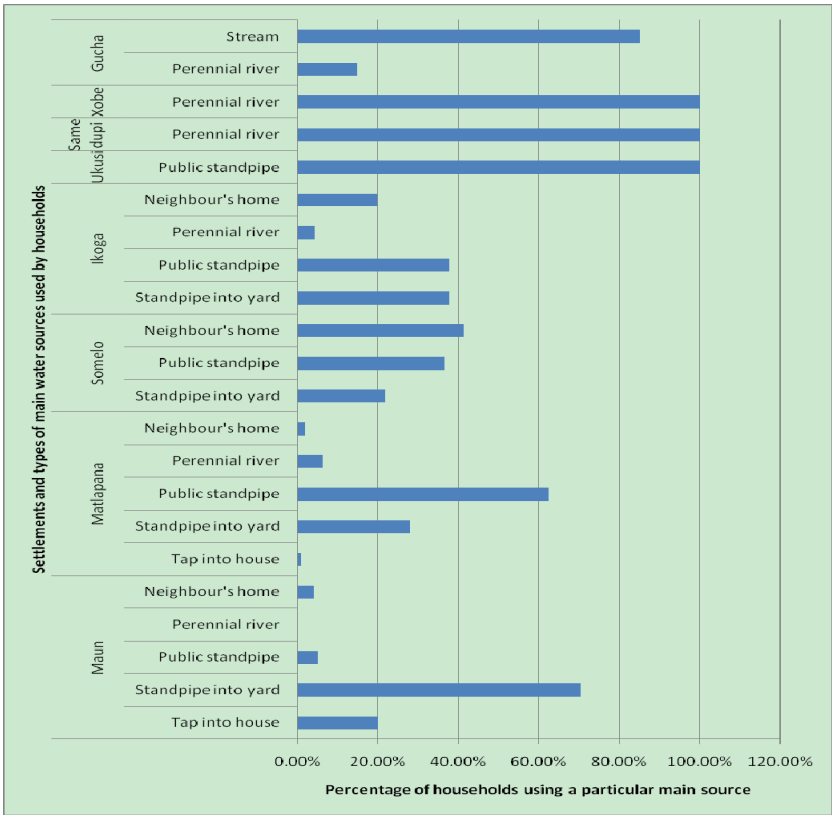

Figure 3. Main water sources for households

Maintaining the functionality of public standpipes is a challenge across all settlement categories (Table 3).

Table 3. State of public standpipes by settlement

Village		Number of public standpipes	Functional standpipes	Non-functional public standpipes
Ikoga		9	4	5
Maun	Boyei	10	1	9
	Wenela	3	1	2
Matlapana		10	2	6
Somelo		3	1	2

DWA and NWDC officials accused residents of damaging public standpipes and expect them to be repaired by their service provider. Maun residents said that the DWA closed down public standpipes as a way of forcing households to invest in private standpipes. In February 2014, an official of the WUC told a meeting of residents in Matlapana that the Corporation has plans to install pre-paid public standpipes which do not have taps that are easily damaged by either people or livestock. Households will be accessing water using pre-paid cards.

4.3 Household Water Insecurity

Water security is regarded by households as the presence of improved sources, and availability and accessibility of good quality water from such sources all the times. Water insecurity is viewed as unavailability of water from improved sources for 1 hour to years and availability of bad quality water, i.e. discolored, bad smell or with sediments. Ungazetted settlement households further regard water insecurity as the lack of improved water supply sources and services in their areas.

Sixty percent (60%) of the households across all the settlement categories highlighted that between 2005 and 2011 they faced serious episodes of water insecurity. There are no significant statistical differences between male and female headed households and water shortages experienced. The situation worsened as 74% of households across all the settlements faced water shortages 12 months preceding the survey. Thirty-three percent (33%) of the households had no water supply within the previous 24 hours of the survey and 32% did not have water supply at the time of the survey.

In March 2011, residents of Maun demonstrated over poor water supply and quality at the DWA offices. During the demonstration, a petition was presented to the District Commissioner who was requested to pass it on to the Minister of Minerals, Energy and Water Resources. The petition implored the Minister to intervene as residents were going for up to a month without water since 2000. No formal communication came back from the Minister and no improvement in water supply was immediately experienced.

Households (100%) from Matlapana and Somelo last received water supply services in 2009. On the hand, households in Maun could go for a month without water supply. All (100%) of households from Gucha, Samedupi and Xobe said that they have always lived in a lifeworld of water insecurity since they use untreated water for domestic purposes. They share their water sources with domestic and wild animals that pollute the water through their droppings.

4.3.1 Response to Household Water Insecurity

There is a statistical association between water insecurity and accessing untreated water by households across all the different settlement categories (Pearson's chi-square, degrees of freedom = 7, p=0.000), significant at 5% level. Household from Maun Village (35%), Matlapana (96%) and Ikoga (93%) regularly access untreated water whenever they experience water supply shortages. Matlapana and Maun households access water from Thamalakane River while Ikoga Village households do so from Ikoga River.

Households from Samedupi (100%) and Xobe (100%) access untreated water from Boteti River while those from Gucha (100%) from Kwenookore stream. The Boteti River is perennial but dries up during other years, e.g. between 1987 and 2006. During this period household members from Samedupi and Xobe dug unprotected wells in the floodplain from where they accessed water for domestic purposes.

4.4 Fetching Water during Periods of Water Insecurity

Women and girls (10 years and above) (96%) across all the different settlement categories, are responsible for ensuring household water availability. Participants at FGDs and informal interviews said that the majority of men see their main duty as that of taking care of livestock while women do other duties which include fetching

water. Chi-square test of independence shows that there is strong association (degrees of freedom = 7, p=0.000, significant 5% level) between water shortages and male household members who do not want to assist in fetching water.

However, changing circumstances within the lifeworld of households in different settlement categories is driving some of the men to become active actors in the provision of water during periods of water insecurity. In Somelo, where water insecurity has been acute, all (100%) of the able bodied men participate in fetching water. In 27% of the households across different settlement categories, male members assist women in fetching water. Such men realise that their assistance is crucial given the multiplicity of tasks that have to be performed by women on a single day such as cooking, general cleaning, fetching firewood and doing laundry. However, men prefer to use assets such as donkey drawn carts and vehicles which do not cause much physical strain on them when fetching water.

4.4.1 Time Taken to Fetch Water

There are significant differences between different settlements and the average time women spent fetching water during periods of insecurity (e.g. shortages) (Table 4). Women from ungazetted settlement take 1:3 as much time as those from gazetted settlements fetching water from untreated sources. Women from gazetted settlements households spend an average of 68 minutes per trip (i.e. Maun, 83, Matlapana, 56 and Ikoga 60 minutes respectively). Women from ungazetted settlements spend an average of 91 minutes per trip fetching water. As a result of the time taken to fetch water by women, they encounter difficulties in balancing time for children and biological needs of their spouses.

Table 4. Time taken by women to fetch water (Kruskal-Wallis 1-Waye ANOVA test)

Village to village relationship	**Significance level**
Matlapana-Ikoga	0.000**
Matlapana-Xobe	0.000**
Matlapana-Samedupi	0.000**
Matlapana-Maun	0.000**
Matlapana-Gucha	0.000**
Matlapana- Ukusi	0.264
Ikoga-Xobe	0.082
Ikoga- Samedupi	0.000**
Ikoga-Maun	0.000**
Ikoga-Gucha	0.000**
Ikoga-Ukusi	0.000**
Xobe-Samedupi	0.556
Xobe-Maun	0.000**
Xobe-Gucha	0.000**
Xobe- Ukusi	0.000**
Samedupi- Maun	0.004*
Samedupi – Gucha	0.000**
Samedupi-Ukusi	0.000**
Maun-Gucha	0.005*
Maun-Ukusi	0.000**
Gucha-Ukusi	0.478

**Highly significant at<p=0.000

*Significant at p=0.05

In order to minimize the number of trips per day, all able bodied adult female members and children of households go to fetch water using containers of various sizes. The majority (78%) of the women fetch water two times a day, early in the morning and late in the afternoon or evening. School going children usually fetch water once after school and at least two times a day during weekends and holidays.

Some women from households in Maun prefer fetching water from the river despite the fact that storage tanks were put up by DWA in their areas. This is, because of the time spent queuing for water as it takes 7:21 minutes to fill one 20 L container at some of the storage tanks. There could be more than 80 containers to be filled. A number of women leave their containers in the queue and request someone to push them forward while they go back home to do other domestic duties.

In Somelo village, women and men usually wait for the water tanker to deliver freshwater from Maun which is off loaded in the village's 20 m^3 tank. The water is accessed through public and private standpipes. Pressure of the water from the functional public standpipe is usually low as one 20 L container can take up to 6 minutes to fill up. Each household could come to the public standpipe with up to 10 x 20 L containers resulting in people queuing for more than 3 hours and others failing to get the water as it get finished quickly.

4.4.2 Assets Used by Different Gender Groups to Fetch Water

Water insecurity generates differential patterns of responses (heterogeneity) in terms of the assets used to transport water by men and women based on gender and socio-economic status (Long & Van der Ploeg, 1994). The most common assets used by women, girls and children when fetching water are 20 L or 25L plastic containers. Men usually use donkey drawn carts while households which are economically well off, use light vehicles.

4.4.2.1 Head Loading Water Filled Containers

Carrying water on the head using containers is an arduous task which takes up considerable time and energy. There is a statistical association between water shortages and the use of 20 L plastic containers by women and girls to fetch water (Pearson's chi-square test, degrees of freedom = 4, p=0.002), significant at 5% level. However, there is no statistical association between children aged between 5 and 11 and the use of any particular types of containers used for fetching water. This age group uses an assortment of containers ranging from 2 L to 10 L.

Women from different settlement categories complain of head loading water containers as this results in pain around the neck and back. The situation is exacerbated when one is pregnant or carrying a child on the back. The majority of women at FGDs highlighted that they always feel physical pain associated with head loading of water but they do not have any option as they are expected to fetch water.

4.4.2.2 Use of Donkey Drawn Carts

Kruskal Wallis 1-Way ANOVA test shows that there are highly significant differences (p=0.000, significant at 5% level) between households owning donkey-drawn carts used for fetching water and those without, across the different settlement categories. Donkey drawn carts are used by male members of households from the age of 15 from Gucha (20%), Ukusi, Maun (4%), Matlapana (25%), Xobe (35%), Samedupi (35%), Ikoga (18%) and Somelo (27%) to fetch water from different sources during times of water insecurity or where there are no supply services. The use of donkey drawn carts allows the transportation of 0.5 m^3 of water or more on a single trip. Some of the households (17%) without donkey drawn carts either hire or borrow from those who own them to enable them to transport water.

Water transported by a donkey drawn cart can last the household for more days, depending on household size and uses, than the one collected by head loading. This relieves pressure on women from making many trips to various water sources on a daily basis. One male household head in Gucha can transport 0.4 m^3 of water on a single trip from a neighbouring village situated 5 km away. However, whenever the cart breaks down, the wife walks 4 km to a nearby stream to fetch water using a 20 L container with a child strapped on the back.

4.4.2.3 Use of Light Vehicles

Sixteen percent (16%) (i.e. Maun, 12% and Matlapana, 2% in and 1% in Samedupi, and Somelo respectively) of households across all the settlement categories use light vehicles during periods of water shortages to transport water in small containers from areas where it is available. There is also a statistical association between households using light vehicles to fetch water and monthly income (Pearson's chi-square test, degrees of freedom = 5, p=0.000), significant at 5% level. Eighty-percent of households using light vehicles have monthly incomes of BWP5000 and above.

Informal interviews and FGDs revealed that male members of households prefer to fetch water using vehicles as it is easier than using a single container carried over a certain distance. They refrain from fetching water whenever light vehicles used are not available for the task. In such cases, female members of households are compelled to use containers to fetch water from other sources.

4.4.2.4 Bulk Water Supply and Buying

Water shortages in Maun and Matlapana resulted in the formation of a bulk water supply and buying market. Direct observation and informal interviews conducted with bulk water suppliers, revealed that the market emerged around 2000. Water is supplied to households, business premises and educational institutions which can afford the charges that are much higher than WUC charges (e.g. BWP150 for 2.5 m^3, BWP300 for 5 m^3 and

BWP600 for 10 m^3). The suppliers abstract water from Thamalakane River, private boreholes or buy from WUC and then put a markup. Trucks which carry storage tanks ranging from 2.5 m^3 to 10 m^3 are used to transport the water.

The businesses of bulk water supply are all owned and run by men as well as the deliveries. Women interviewed said that they have never considered venturing into this business. Men are preferred to drive the trucks and operate the water pumps because they have the requisite driving licenses for the trucks used and are seen as able to cope with the physical demands of such a job as deliveries can be done during the day, at night, weekends and public holidays.

Both male and female headed households which are economically well off and who prefer bulk water, buy it. Households which buy 5 m^3 are able to last for more than a month with this water. In such cases, female members of the households do not have to go and fetch water elsewhere using containers.

4.4.2.5 Rainwater Harvesting

Sixty-three (63%) of households across the different settlement categories practice rainwater harvesting. There is a statistical association between water insecurity and rainwater harvesting (Pearson's chi-square test, degrees of freedom = 7, p=0.001), significant at 5% level. Traditional rainwater harvesting, using open containers ranging in sizes from 20 L to 210 L are placed below the rooftops during the rainy season, is mainly practiced by women in 58% of the households. This technique is preferred by 100% of women because it is simple and there are not much costs involved. Through this activity, women are able to reduce the number of trips to other water sources. If a household is able to harvest 0.5 m^3 of water, this can result in this water being used for a number of days depending on the size of the household and amounts used for different activities. One household in Matlapana reported harvesting more than 200 L from a single heavy rainy event. The majority (89%) of households harvesting rainwater view its quality (i.e. in terms of taste and color) as better compared to that from untreated sources and improved sources.

Direct observation and case studies revealed that men in Maun, Matlapana, Somelo and Ikoga assist women in rainwater harvesting by designing improvised rainwater harvesting systems from rooftops into storage tanks ranging from 0.210 m^3 - 0.5 m^3. Water from the rooftops is channeled through polythene or polyvinyl chloride (pvc) pipes.

Five percent (5%) of households across the different settlement categories practice rainwater harvesting using proper equipment. These are mostly from Wenela ward in Maun and those residing in government houses at health centers and schools in gazetted settlements. The houses are fitted with gutters which channel water into 5 m^3 or 10 m^3 storage tanks. Some of the households are able to use the water until the next rainy season since they only use the water when there is no supply from their main sources. The households are not worried by the fact that the quality of the water degenerates with time.

4.5 Water Insecurity and Personal Hygiene

Individual actors from different households value personal hygiene especially bathing but this is usually negatively affected by lack of/or less water. This results in household members, both men and women, reducing the frequency of bathing, amount of water used for bathing or do not bath at all. In 72% of the households, water availability determines whether household members have to bath. There is a statistical association between water availability in the household and bathing (Pearson's chi-square, degree of freedom = 7, p=0.000), significant at 5% level. Kruskal Wallis 1–Way ANOVA test shows that there are significant differences (p=0.000) in the amount of water used by household members to bath between different settlement categories of Ngamiland when there are water shortages.

Seventy-one percent (71%) of the women and 57% of the men across the different settlement categories prefer to bath two times a day when water is readily available. However, when water insecurity persists, they all bath once a day. In some instances, bathing is skipped for between one day and 5 or more days especially by male members of households.

Women (100%) feel that they are more disadvantaged by water insecurity more than men. While men can go for a longer time without bathing, it creates serious challenges for them due to the fact that they experience monthly menstrual periods which creates the need for them to bath regularly.

4.6 Social Relationships during Times of Water Security Problems

4.6.1 Inter-Personal Conflicts over Water

Participants at FGDs and informal interviews revealed that household members across all the different settlement

categories experience conflicts over the use of water stored in households during times of water shortages. There is a statistical association between water shortages and misunderstandings between and among household members (Pearson's chi-square test, degrees of freedom = 7, p=0.000) highly significant at 5% level. Across all the settlement categories, 61% of the households' members have misunderstandings related to water usage, amount used and purpose of use. Most of the conflicts are verbal in nature.

In Somelo village there is usually a lot of pressure on the functional public standpipe and households cannot agree on how many containers each person should fill up before giving others a chance. Most households go to the standpipes with as many as 11 containers resulting in some households failing to get water. Those at the back of the queue usually complain that they would be denied water since it gets finished before they can fetch any.

Health personnel in Somelo used to allow households to fetch water from a standpipe within the health post premises but this changed in May 2014 when households were denied access. Households were told that they were damaging the standpipe just like they destroyed their standpipes. The move angered the households who called for a meeting which was addressed by the traditional leader of the area. The households told health post personnel that the water and the standpipe was theirs and they should not be denied access. They further threatened the health post personnel with expulsion from the village if they continued denying them access to the standpipe. The threats did not yield any changes from the health post personnel. However, whenever other health post personnel are not present, the security guard who is from Somelo, allows members of households to fetch water from the standpipe.

4.7 Fetching Water from Neighbour's Standpipes

Some private properties in Maun and Ikoga always have water available from their standpipes when others do not have any. Ikoga village has one residential property which always has water available during times of shortages. Other households were allowed to fetch water from this private standpipe during periods of water shortages. Until January 2014, owners of this property paid a fixed monthly fee of BWP5.75 because the standpipe did not have a meter. In February 2014, WUC installed a meter on the standpipe and this resulted in the household denying other households access to their standpipe fearing high water charges. As a result some of the households secretly fetch water at night when the owners are indoors or asleep.

Some households in Maun which always have uninterrupted water supply, while other households would be experiencing shortages assist those experiencing acute shortages. In one case, a property with continuous water supply is inhabited by women who are mostly into commercial sex work. As a result some men go to this property pretending to be fetching water but in actual fact seeking services of the women. Some of the households with standpipes with continuous water supply in Maun charge BWP5 for each 20 L container filled with water from their standpipes.

Water shortages in Somelo led to the sexual exploitation of women in 2011 and 2012. This was as a result of men from a mineral prospecting company based closer to the village that had water brought for them by a water tanker. Some women and girls from the village in dire need of water fell vulnerable to the men who lured them into sexual relationships in exchange of water.

5. Discussion

The greatest global development failure by the international community in the 20th century which has spilled over into the 21st Century, is the inability to provide clean and safe water to all as 1.1 billion people are water insecure (Onda, LoBuglio, & Bartram, 2012). Factors behind global water insecurity include rapid population growth, rural–urban migration, increased per-capita water use, pollution of water resources, over-abstraction of groundwater, poor water governance and climate change and variability (Jones, Vardianian, & Hakopian, 2009; Vörösmarty et al., 2010). Ineffective water governance could be the major contributor to global water insecurity because of lack of resilient institutions, collaborative efforts and sound capacity at all levels to manage scarcity and water related risks (such as floods and natural disasters) in developing countries (Harris, Goldin, & Sneddon, 2013). Countries facing water insecurity need to put in place policies and institutions that promote good water governance with the capacity to implement programmes that ensure water security.

Though countries such as Botswana, South Africa and Namibia pursued policies of planned intervention which resulted in the provision of improved water sources (Long & van der Ploeg, 1989a), in some instances, as in Ngamiland, households do not always have reliable water supply from such sources. Information on access to water in some developing countries masks the reality of water security at the local level. Data is mostly given in relation to the physical infrastructure installed and not about its functionality, e.g. in Botswana, 97% of the population has access to improved water sources, but in Ngamiland, 74% of households are encountering water

insecurity. In South Africa, 95% of the population has improved water sources but this does not entail access to clean water (Rademeyer, 2013). Demonstrations against poor service delivery, including poor water supply in urban centers in recent years in South Africa points to water insecurity (Rademeyer, 2013). In Jordan, 97% of the population has access to improved water sources, but this does not always guarantee access to water as the country is water scarce (Hadadin, Qaqish, Akawwi, & Bdour, 2010). There is need for the use of water security (i.e. access, availability, quality, quantity, reliability and affordability) as a measure of access to water rather than considering the presence of improved sources only.

The analysis of gender and other social dimensions of water insecurity at a micro-level through the use of the actor oriented approach, has shown that households, men, women, girls and children actors existing in water insecurity lifeworlds, play different roles in ensuring household water availability. Women and girls have the greatest agency in ensuring household water availability during periods of water insecurity as they sacrifice time for other activities in order to ensure that there is water at the household level. Women's agency during periods of water insecurity is mainly limited to the use of small containers loaded on their heads which have to be carried over an average distance of 3.5 miles each day from untreated sources (Thompson, 2001). This head loading of water containers has potential long-term health effects as it makes demands on the metabolism of the body not met by the nutritional intake and by regularly putting an excessive strain on the skeleton, leading to spine deformities and early onset of arthritic diseases (Geere, Hunter, & Jagals, 2010).

Research elsewhere has confirmed that women, girls and children are the most common water carriers around the world, and they spend considerable time supplying water to their households (Ngwenya & Kgathi, 2003; Sorenson, Morssink, & Campos, 2011). There is generally a direct positive association between water scarcity and women as water fetchers (Sorenson et al., 2011). For example, in Mauritania, 70% of water carriers are women in households without improved water sources (Sorenson et al., 2011). In cases where men assist in carrying water, they prefer to use assets such as donkey drawn carts or light vehicles as they do not want to carry containers over long distances.

The gendered division of labour in other sectors of the economy is also found in the water sector as women are expected to provide water for the household while men engage in water related business such as bulk water supply markets (Kjellén & Macgranahan, 2006). Such markets emerge across the developing world where water shortages are common (Hinkfuss, 2013; Manzungu & Chioreso, 2012b). In Dar es Salaam and Nairobi, where women carry water home, men constitute the majority of water vendors (Kjellén, 2000).

In the context of increasing water insecurity, i.e. failing or absence of conventional portable water supply services, rainwater harvesting by households can supplement water for domestic use (e.g. drinking, washing and cooking) (Warm & van Hattam, 2006). Women practicing traditional rainwater harvesting are well aware of the limitation of their lifeworlds (Long, 1990a) in terms of access to water and they view this activity as an option that enhances household water availability. Water policy in Botswana can focus on training households on how to practice rainwater harvesting, i.e. putting the infrastructure in place as well as maintaining it. Incentives which include provision of tanks and gutters can be put in place so as to motivate households to practice this activity. The capturing of rainwater helps women to minimize trips to collect water from untreated water sources. Australian states like South Australia and Victoria put in place regulations which require all private property owners to install at least a 5 m^3 tank for rainwater harvesting to enable the capturing of rainwater for the household's own use (Imteaz, Shanableh, Rahman, & Ahsan, 2011).

Water insecurity generally impacts negatively on personal hygiene as those actors affected forego basic chores such as bathing making them prone to water related diseases (Mukuhlani & Nyamupingidza, 2014). Households usually act rationally during periods of insecurity and prioritise important aspects such as drinking and cooking and neglect essential aspects such as bathing (Mukuhlani & Nyamupingidza, 2014). The same strategies were observed in Harare and Bulawayo as households internalized prevailing water shortages (Manzungu & Chioreso, 2012b; Mukuhlani & Nyamupingidza, 2014). Diseases related to unsafe water, poor sanitation and lack of hygiene are some of the most common causes of illness and death among the poor of developing countries (Tarrass & Benjelloun, 2011).

Within the lifeworld of water insecurity, households strive to develop networks with other households and individuals which yield water related benefits (Tilly, 1995). Some studies on water security have shown that households have the tendency of assisting each other during periods of water shortages (Chaminuka & Nyatsanza, 2013). Households with private water sources which always yield water, sometimes share water from these sources with their neighbours for free or for cash. It was noted that in Malawi, households without their own private water connections buy water from those owning private connections (Manda, 2009).

Policies and programmes aimed at addressing water insecurity on a short and long term basis in developing countries (i.e. low and middle income countries) are important as they contribute towards gender equity and social development (Savenije & Van der Zaag, 2008; Sorenson et al., 2011). Failure to provide adequate and safe water through improved sources will continue to disadvantage women, girls and children as they are culturally expected to ensure water availability at the household level (UNFPA, 2009). It is imperative for countries to ensure that infrastructure installed for supplying households with water do so on a sustainable basis so that women and children will not be disadvantaged when the sources fail to provide water as what is obtaining in gazetted settlements in Ngamiland.

Countries facing water insecurity need to put in places policies, strategies and interventions capable of enhancing household water security. In the short-term, WUC needs to ensure the functionality of improved sources on a sustainable basis and where challenges are encountered, water tankers can be used to provide clean water for households. This will reduce the distance travelled by women to untreated water points. Households from ungazetted settlements such as Gucha which are located along water transmission lines could be connected to these to allow households to access water from public standpipes as is the case with Ukusi. Other ungazetted settlements such Xobe and Samedupi can get state assistance to sink solar powered boreholes (operated and maintained by trained villagers, both men and women) along the floodplain of Boteti River which can enable households to access water from central locations. In order to phase out head loading of containers by women, the wello water wheel, a drum which can be filled with water and rolled home on the ground with minimum effort can be introduced (Rahman, 2011).

Long-term efforts to curb water insecurity need to focus on the crafting of clear and effective policies, legal frameworks and strategies coupled by proper planning, political will and financial and material resources. Countries facing water insecurity can learn from developed world countries (i.e. France, Germany, United States of America and United Kingdom) which managed to put in place a package of policies, laws, financial mechanisms and technologies which enhanced water security during the 19th Century in cities that were previously centers of infectious diseases due to water insecurity (UNDP, 2006). Water security was placed at the center of the development agenda. If developing countries adopt the same approach of making water security a development priority, there could be a drastic improvement.

6. Conclusion

Households in Botswana in general and Ngamiland in particular are being negatively affected by water insecurity despite the fact that gazetted settlements have improved water sources. Access to clean and safe water in Botswana and other countries is still defined terms of the presence of improved sources which can go for prolonged periods of time without providing any water. Water security has to be defined in terms of improved sources as well as access, availability, quality, quantity, affordability and reliability of water supply.

Water insecurity has gender and other social dimensions. Women, girls and children are the actors expected to ensure water availability during periods of water insecurity and this takes a considerable amount of their time which could be used for other productive activities. Women and girls mainly use containers which they load on their heads to transport water to the homestead while men prefer to use assets such as donkey drawn carts and vehicles to transport water as these do not cause much physical strain on them.

Rainwater harvesting contributes significantly to household water supply and limits the number of trips to untreated water sources by women. There is need for policy to promote rainwater harvesting in countries like Botswana in general and Ngamiland in particular where households face water insecurity. Incentives such as the provision of rainwater harvesting infrastructure at subsidized rates can go a long way in encouraging households to adopt the activity.

Water security compromises personal hygiene of household members and also breeds conflicts in households as members do not agree on quantities of water to be used on certain activities. This makes it imperative for the implementation of measures which can address water insecurity.

Countries affected by water insecurity need to craft and implement policies and strategies that enhance water security (e.g. in both gazetted and ungazetted villages) as this will address issues of gender inequity and negative social issues associated with water insecurity. Policies need to focus on ensuring that improved water sources infrastructure provide water on a sustainable basis. Households can be made to be active participants in the provision of water through rainwater harvesting. Policy and programmes need to ensure that ungazetted settlements receive water supply services.

Research has to underpin any policies and programmes aimed at enhancing household water security. This

include policy options for rainwater harvesting, functionality of the already installed water infrastructure, connection of ungazetted settlements located along water transmission lines, the supply of water to other ungazetted settlements and impacts of head loading of water by women. More research is needed on the appropriate water fetching assets that can be used by women to fetch water away from the homestead.

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Note

Note 1. USD1 = BWP8.6

CHAPTER SIX

Water governance and household water security in Botswana: The case of Ngamiland District

By

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Abstract

The paper analyses water governance approaches being used in Botswana in general and Ngamiland in particular in order to enhance household water security. Qualitative (that is, key informant interviews, focus group discussions, and participant observation) and quantitative (structured household questionnaire) data collection methods were used. The concepts of water security, water governance and the integrated water resources management approach underpin the paper. There is water insecurity in Ngamiland which is partly a result of poor water governance. The water legislative framework for Botswana does not reflect current water management approaches such as IWRM and there is no policy to guide developments for the water sector. Institutions involved in water supply have not been effective in ensuring sustainable water supply for households in order to enhance water security. There is an absence of forums for stakeholders to have a role to play in water governance. Water is still seen as a social good in Ngamiland. There is need for Botswana to come up with a legal and policy framework which reflects current water governance approaches such as IWRM to enhance household water security and stakeholder participation in water management.

Key words: Water governance; water security; households; Ngamiland; Botswana

1. Introduction

The 21st century has witnessed the unfolding of multiple water challenges which require a substantial shift in the way natural resources in general and water resources in particular are

managed (Nayar, 2013). Global water reforms have been put in place and substantial investments (of over $15 billion globally) in the developing world have been made, but the water crisis has deepened (Jones et al., 2009; Saletha & Dinarb, 2000). Despite billions of dollars invested annually in the water sector, 1.1 billion people live without clean drinking water, 2.6 billion people lack adequate sanitation and 1.8 million people die every year from waterborne diseases (Onda et al., 2012; UNESCO, 2009). It is predicted that by 2025, 3.4 billion people will be living in countries defined as water scarce (UN-Water, 2005).

The global water crisis has been defined as a crisis of governance, that is, the failure of water institutions to manage the resource for the well-being of humans and ecosystems (Gupta, 2011). Ineffective governance in most of the developing countries manifests itself in fragmented institutional structures, lack of clarity of roles and responsibilities, improper resource allocation, poor financial management, weak accountability of water management institutions and policy-makers, unclear or non-existent regulatory environments, and unpredictability in the investment climate for private sector actors (UN, 2006). Over the past decades, there has been progress in developing the technical solutions in the water sector without much emphasis on governance (Bigas, 2012).

Ineffective water governance is one of the factors behind Africa's inability to meet the Millennium Development Goal (MDG) 7, target 10, which aims at halving the number of people without access to safe and clean drinking water (Onda et al., 2012). An estimated one million deaths that occur in Africa are caused by waterborne diseases due to the use of untreated water (Eneh, 2011). For the continent to be able to meet the MDG 7, target 10, at least 38 million people in Africa should have sustainable access to clean water through improved water sources annually between 2008 and 2015, and not only the 15 million people who have already gained access to clean water (Eneh, 2011).

Since the 1990s, there has been a transition towards more integrated management methods and approaches to water resources given the global water governance crisis (Adil, 1999; Biswas, 2008). The traditional, fragmented and purely sectoral approach in the management of water resources is no longer viable and there is a need to move towards a more holistic and integrated approach (Harris et al., 2013). The 1990s witnessed a global shift in water governance as policy reforms leaned towards the adoption of integrated water resources management (IWRM) approach which was seen as having the potential to enhance efficient

and sustainable development and management of the world's limited water resources and for coping with increasingly conflicting demands by different sectors. The IWRM approach was developed and popularised by international conferences such as the Rio and Dublin Conferences of 1992, Second World Water Forum (2000), International Conference on Freshwater (2001), World Summit on Sustainable Development (2002), and Third World Water Forum (2003) (Giordano & Wolf, 2003). These conferences paved the way for IWRM to be put on the political agenda. The recognition of the approach by the United Nations (UN) gave IWRM an official status as an appropriate global water management framework (Keskinen, 2010).

The concept of IWRM is defined as a process that promotes the coordinated development and management of water, land and related resources, in order to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems (GWP, 2000a). The IWRM approach includes elements of good water governance, such as equity, participation, coordination, sustainable development, and inclusiveness (GWP, 2000a). Organizations such as the World Bank and the European Union include in their packages for financial assistance to developing countries, the need for water reforms, water policies and legislation; the establishment of apex agencies for water management, and the creation of platforms for stakeholder participation (Hering & Ingold, 2012).

The Southern African Development Community (SADC) adopted IWRM as an approach for the management of the region's 15 transboundary basins (SADC, 2011). A number of Southern African countries which include Malawi, Mozambique, South Africa, Tanzania and Zimbabwe embraced IWRM and put in place policies and legislation which include elements of IWRM (Kujinga & Jonker, 2006; Kujinga & Manzungu, 2004). Countries such as Botswana have embraced the IWRM approach, but are still in the process of reforming their water sectors so that they can be in line with IWRM principles.

This article, therefore, analyses water resource governance in Botswana and how it impacts on household water security. The paper further analyses the extent to which Botswana has adopted IWRM principles and the impact that this is having on household water security.

2. Analytical Framework

The paper is underpinned by the concepts of water security (Ariyabandu, 2001; Grey & Sadoff, 2007); and water governance (Castro, 2007; Helen, 2011; Rogers & Hall, 2003), including the IWRM approach (GWP, 2000a; Stålnacke & Gooch, 2010; Vanderzaag, 2005). Security refers to freedom or protection from serious risks and threats and it is one of the basic needs for human beings (Baldwin, 1997; Buzan, 1983; Soroos, 1994; Weaver, 1996). Water security entails water availability as well as its quality for human wellbeing both in the present and in the future (Buzan, 1983; Grey & Sadoff, 2007; Soroos, 1994). One of the goals of water governance is to achieve water security by enhancing efficient water supply for human well-being (GWP, 2000b). Governance in general refers to how economic, political and administrative authorities exercise their roles in the management of a country's affairs at all levels (Lautze et al., 2011; Pahl-Wostl et al., 2010). The process of governance comprises the mechanisms, processes and institutions through which citizens and groups articulate their interests, exercise their legal rights, meet their obligations and mediate their differences (Pahl-Wostl et al., 2010).Water governance refers to the range of political, social, economic and administrative systems that are in place to develop and manage water resources, and the delivery of water services, at different levels of society (GWP, 2000).

Achieving water security can be done through clear and effective political, social, economic and administrative systems (World Bank, 2010). Good water governance guarantees households water for both domestic and productive purposes in the face of water vulnerability (Grey & Sadoff, 2007). Water security refers to access to enough safe water at affordable cost for people to lead a clean, healthy and productive life while ensuring that the natural environment is protected and enhanced (GWP, 2000b). Household water security refers to "accessibility, reliability and timely availability of adequate safe water to households to satisfy basic human needs" such as drinking, cooking, sanitation and bathing (Ariyabandu, 2001: 8). A household denotes an institution of two or more people (not necessarily permanent), whose primary feature is co-residence, eating and pooling resources together as well as involvement in the provision of essential resources required for a living (Beall & Kanji, 1999; UN, 1976).

IWRM is an approach which aims at improving water governance by enhancing inclusive decision-making to secure more equal water development decisions for all stakeholders, including households and communities (Jusi, 2013). There is increasing consensus within the international community and among different nations that the IWRM approach can act as a

way forward for efficient and sustainable development and management of the world's limited water resources and for coping with conflicting demands (Global Water Partnership, 2009; Hassing et al., 2009). IWRM is defined as a process that promotes the coordinated development and management of water, land and related resources, in order to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems (GWP, 2000a). The approach is underpinned by the following four principles which have a bearing on both water governance and water security:

- Fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment.
- Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels.
- Women play a central role in the provision, management and safeguarding of water.
- Water has an economic value in all its competing uses and should be recognised as an economic good.

IWRM is a cogent approach which includes elements of good water governance, such as equity, participation, coordination, sustainable development, and inclusiveness (Global Water Partnership, 2009; GWP, 2000a).

3. Materials and methods

3.1. Study area

The study was undertaken in the North-West District (also known as Ngamiland) of Botswana (Figure 1) which, according to the 2011 national census, has a population of 158,104 (Central Statistics Office, 2011). The district is administered from Maun Village by the North West District Council (NWDC). For administrative purposes, North West District is further sub-divided into Ngami and Okavango sub-district authorities, administered from Maun Village and Gumare respectively. According to the 2011 national census, Maun Village has a population of 60,263 (Central Statistics Office, 2011).

One of the main physical features of Ngamiland District is the Okavango River which is part of a basin shared between Angola, Botswana and Namibia (Figure 1). The Okavango River in

Botswana forms a large delta-like feature (actually an alluvial fan) which is a Ramsar site and a world heritage site known as the Okavango Delta (McCarthy & Ellery, 1998; McCarthy et al., 1986).

The main commercial activities in the district are tourism and livestock rearing (Motsholapheko et al., 2010). However, Ngamiland has a poverty rate of 37.6% as opposed to the national rate of 20.7% (African Economic Outlook, 2013; Central Statistics Office, 2011) while 15.3% of the economically active population is unemployed as opposed to the national average which stands at 20% (Central Statistics Office, 2011).

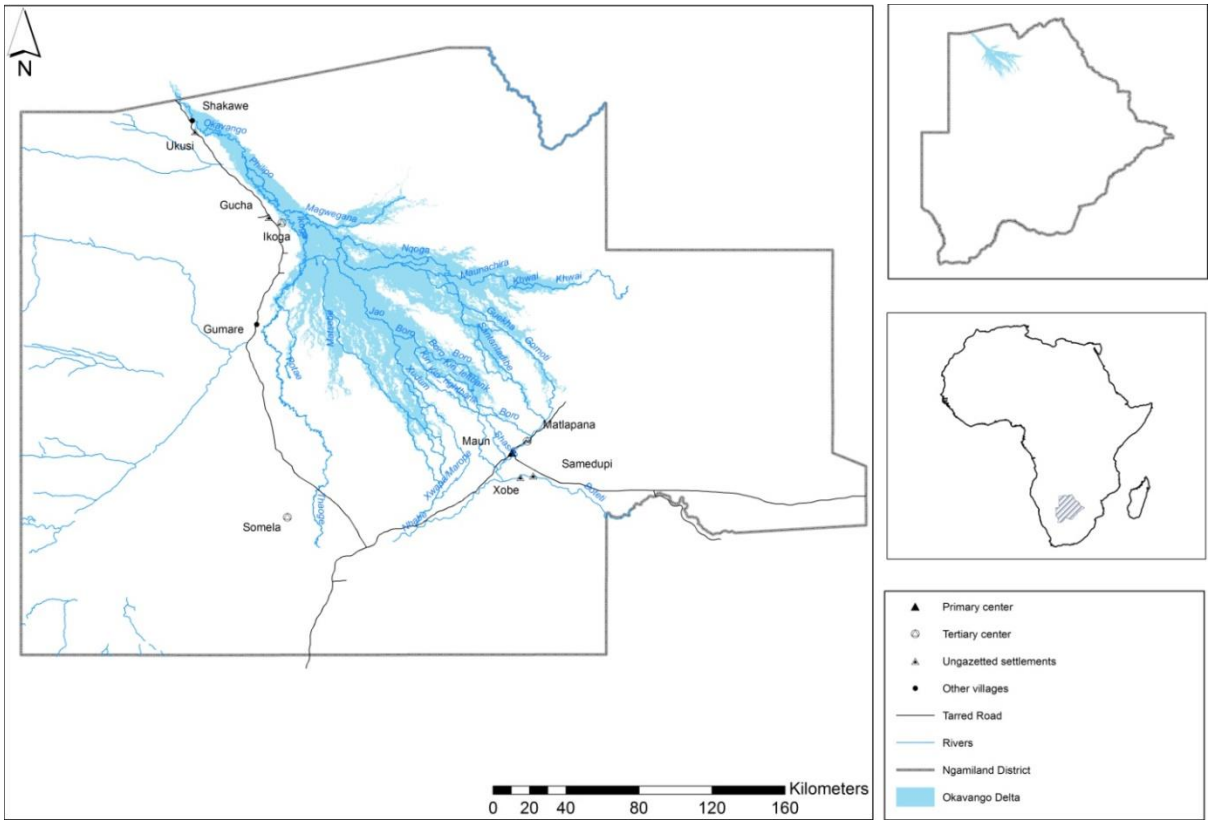

Figure 1: Map showing the study areas (Source: Okavango Research Institute, 2014)

The study was undertaken in gazetted (formal) and ungazetted (informal) settlements of Ngamiland. Gazetted settlements, because of their status, have water supply, roads, schools, health and police services. Gazetted settlements are established based on population size as well as other factors which include economic potential, employment generation, availability of natural resources such as water for sustaining the settlement (Government of Botswana,

1998). Gazetted settlements are divided into three categories, namely, primary, secondary and tertiary centers (Government of Botswana, 1998).

Primary centres are sub-divided into 3 levels and each level has a specific population range, for example, primary centre I, 20,000 – 49,999 (e.g. Maun Village), primary centre II, 50,000 – 99,999 and primary centre III, 100,000 and above (e.g. Gaborone) (Government of Botswana, 1998). The population range of secondary centres is 10,000-19,999. These play a key role as district or sub-district headquarters such as Gumare (Government of Botswana, 1998). Tertiary centre settlements (sub-divided into I – IV) have population ranging from 250 - 9 999 (Table 1) (Government of Botswana, 1998).

Table 1: Tertiary settlement categories

Tertiary center category	**Population range**
I	5,000 – 9,999
II	1,000 – 4,999
II	500 – 999
IV	250 – 499

Source: (Government of Botswana, 1998)

Type I tertiary centres are not found in Ngamiland District though all the other categories, that is, II – IV are there. Ungazetted settlements have a population of less than 250 people and do not have legal entitlement to social services delivery like gazetted settlements (Kgomotso & Swatuk, 2006).

3.2. Data collection methods

Qualitative and quantitative methods were used in the collection of data between February 2012 and March 2014. Qualitative methods were used to gather data on meanings, opinions, feelings and perceptions regarding water governance, water security and IWRM. These issues were not experimentally examined or measured in terms of quantity, amount, intensity or frequency (Neuman, 2000; Schwandt, 1994). Qualitative methods enabled the researchers to interact closely with the households and the service providers who include the Department of Water Affairs (DWA), Water Utilities Corporation (WUC) and the NWDC. The methods employed included key informant interviews, participant observation, unstructured/informal

interviews and focus group discussions (FGDs). Key informants included members of village development committees, ward councillors, traditional leaders and relevant officials from the WUC, NWDC and DWA. The FGDs were conducted with ordinary community members. Participant observation was done in all the settlements where the principal researcher spent some time. The principal researcher resided in Matlapana for three years, a settlement affected by water shortages. Qualitative data collected included water policy and legislation, institutions involved in water supply, and effectiveness in water supply services to settlements and households, stakeholder participation in water management, water pricing and water sector reforms and their impact on water security. Data was also collected from relevant documentation obtained from the DWA, NWDC and the WUC.

Quantitative data collection was carried out through the use of a structured household questionnaire between May and August 2012. This instrument was used to gather data on general household characteristics, that is, gender and age of household heads, household water sources, the extent of water security or insecurity, institutions involved in water management, water policy and legal issues, the extent of stakeholder participation, water pricing and payments.

3.3. Sampling

The study was undertaken in 8 purposively sampled sites. The settlements were purposively sampled for various reasons as articulated in Table 2.

Table 2. Sample sizes by settlement

Settlement	Settlement category	Population size (2011)	Total number of listed households	Number of households sampled	Reasons for sampling
Maun Village[1]	Primary center III	4105	933	295	To understand water governance issues in the only primary center settlement in Ngamiland
Matlapana A	Tertiary center II	1449	329	99	To understand water governance in a tertiary settlement experiencing acute water shortages since 2009.
Ikoga	Tertiary center III	673	153	46	To explore water governance in a settlement receiving water supply from a surface water treatment plant
Somelo	Tertiary center IV	600	136	41	To understand water governance issues in a settlement located 40km away from surface water resources.
Gucha	Ungazetted	88	20	20	To understand water governance issues in a settlement designated as ungazetted in Ngamiland
Samedupi	Ungazetted	286	65	20	
Ukusi	Ungazetted	261	60	19	
Xobe	Ungazetted	260	60	20	
Total		7722	1571	554	

(Sources: Central Statistics Office 2011; Study settlements' records; Kujinga et al, 2014)

A 30% household sample size in all the settlements was adopted (see Table 2) using population information from the Central Statistics Office, NWDC and local village leadership. Households in each settlement were listed and each (household) was assigned a randomly generated number. Trained enumerators administered questionnaires to household members from the age of 15 who had information on household water issues. Sixty-two percent (62%) of the respondents were women. A total of 554 questionnaires were administered.

Participants for FGDs were randomly picked from male and female-headed households from different areas of each settlement. The participants included those interviewed in the survey as well as those who were not interviewed. At least one FGD was held in each study settlement. Each FGD was attended by at least 16 participants. Key informants were purposively sampled from settlements, DWA, WUC and NWDC.

4. Results and analysis

4.1. Access to water sources and household water security in Ngamiland

Overall water governance (e.g. policy) in Botswana put more emphasis on ensuring access to water for domestic purposes for all households in gazetted settlements from improved sources within a distance of not more than 400 m (Department of Environmental Affairs, 2008). This has enabled the country to achieve 97% coverage in terms of access to improved water sources for the population. There is a statistical association between settlement category and type of main water sources used by households (Pearson's chi-square value = 1203.1919, degrees of freedom = 42, p=0.000), significant at 5% level. Eighty-eight percent (88%) of the households across the different settlement categories have access to improved domestic water supply sources, that is, public standpipes (23.1%), standpipes in yard (46.8%), taps inside the house (10.8%) and neighbour's standpipes (7.2%). Twelve percent (12%) of the households who access water from untreated sources are mainly from ungazetted settlements (see also Kujinga et al., 2014). Households from primary centre (Maun Village) and tertiary centres (Ikoga, Matlapana and Somelo) have improved water sources, while ungazetted settlements (i.e. Gucha, Samedupi and Xobe) access water from untreated sources, rivers or streams. Ukusi is an exception as the households in this settlement access water from public standpipes.

4.1.1. Water insecurity in Ngamiland

Though the majority of households (88%) in Ngamiland have access to improved water sources, this has not guaranteed access to water on a sustainable basis. Seventy-four percent (74%) of the households across all the settlements experienced extreme water shortages from June 2011 to June 2012. During the time of the survey, 33% of the households in gazetted settlements had experienced a cut-off in supply within the previous 24 hours while 32% did not have water supply from their main sources. All the surveyed households from Matlapana and Somelo were last supplied with water from their main sources in 2009. All households from ungazetted settlements, that is, Gucha, Samedupi and Xobe, use untreated water accessed from rivers and streams, which has a high potential to be polluted by droppings from wild and domestic animals.

Key informant interviews as well as a review of literature revealed that settlements such as Maun Village have been facing water insecurity since the turn of the century. This was also

revealed in a petition submitted by residents to the Minister of Minerals, Energy and Water Resources through Maun Village DWA Station Manager in March 2011. The petition highlighted that Maun Village has been facing water shortages for over 10 years. In some cases, most residential wards in Maun Village could go for more than a month without receiving water supply. In the petition, residents also raised complaints about the poor quality of the water that they were receiving.

4.2. Policy and legislative environment for water governance in Botswana

Some households (63%) across the different settlement categories of Ngamiland are aware of the existence of legislative and policy provisions for water management, but are not well versed on actual content of these major provisions. The Pearson's chi-square of independence does not show any association between settlement category and knowledge on water policy and legislative framework.

Botswana does not currently have an approved water policy though there is a draft policy of 2011 which is awaiting approval. However, households identified the major provisions of the draft water policy as access to potable water for everyone (77%), provision of water for free (1%), water payments (22%). This draft policy highlights a number issues with regards to domestic water supply. The draft policy is underpinned by the principles of equity, stakeholder participation, participation of women, economic value of water and its sustainability (Government of Botswana, 2011).

Botswana's is regulated by a number of legal frameworks which have been described as old and out-dated. These include the Water Act Chapter 34:01 of 1968, the Boreholes Act, Chapter 34:02b of 1956 and the Waterworks Act Chapter 34:03 of 1968. The Water Act is divided into eight parts which include ownership and inherent right to use of public water (Part II), granting of water rights and revision (Part IV), variation, determination and diminution of water rights (Part V) (Republic of Botswana, 1968a). The Water Act postulates that all water belongs to, and is controlled by the state which delegated power to issue water rights to the Department of Water Affairs (DWA) and the Water Apportionment Board (Swatuk & Rahm, 2004). The Act allows for existing water rights to be suspended in the event of water shortages due to drought or where water is required for public purposes (Swatuk & Rahm, 2004). However, issues related to water resources planning, management

and development are not well articulated in this Act. Stakeholder participation in water management and water quality are also not articulated in this piece of legislation.

The Waterworks Act provides for the constitution of water authorities and their duties which include putting in place infrastructure for water supply as well as the supply of water to users (Republic of Botswana, 1968b). This piece of legislation does not highlight issues of water pricing as well as stakeholder participation. The Boreholes Act provides for the control and sinking of boreholes from a minimum depth of 15 m (Republic of Botswana, 1956). This Act does not delve into issues of borehole management. All the pieces of water legislation were described by a number of officials from the water sector as out-dated and inconsistent with current developments in the sector such as IWRM principles. As a result, they cannot be used as guiding frameworks for effective water resource governance.

4.2.1. Water Accounting for Botswana

Botswana took an important policy step of adopting water accounting as a way of increasing knowledge on the interaction between water and human activity (Molden 1997). The process informs water governance and ultimately enhances water security. Water accounting is a method of organizing and presenting information relating to the physical volumes of water in the environment and economy as well as the economic aspects of water supply and use (Vardon et al., 2006). Botswana's first work on water accounting dates back to the late 1990s when Department of Environmental Affairs produced accounts for the supply and use of water by volume from 1993 to 2003 , as well as partial information about water stocks of reservoirs (NCSA/CSO, 200). In March 2012 the Botswana Government entered into a partnership with the World Bank to develop accounts for natural resources and to value ecosystem services under the Wealth Accounting and Valuation of Ecosystem Services (WAVES) Programme (Seikanyeng et al., unpublished). Water accounting in Botswana is done by the Water Accounting Unit within the Department of Water Affairs.

The Botswana water accounting process seeks to account for all water abstracted, consumed and used within the country (Department of Environmental Affairs, 2006; Seikanyeng et al., unpublished). The Botswana water accounts data is tabulated in the internationally recognized System of Environmental Economic Accounting for Water (SEEA) framework (Centre for Applied Research & Department of Water Affairs, 2014). The key water accounts

sources in Botswana include the Water Utilities Corporation, Ministry of Agriculture and Mines. The water accounts for Botswana have mainly focused on the following areas:

- Stock accounts – assessing the quantity of water resources in the country at the beginning and end of the year and the changes that occur during this period;
- Flow accounts – this category was divided into two groups:
    - Regionalisation of water accounts – to determine the volumes of water used by different sectors in the different management areas as well as the costs incurred by service providers and the revenues attained.
    - Irrigation water use- to determine use of water for irrigation in Botswana primarily focussing on large government irrigation schemes and major private farms (Centre for Applied Research & Department of Water Affairs, 2014).

Information provided through water accounting is necessary to make the right policy decisions regarding water use and management. Though Botswana has put in place this system of water accounting, it has not yet enhanced water governance. The water account unit is centralised in Gaborone and had only six officials who are supposed to cover the whole country (Seikanyeng et al., unpublished). Ngamiland does not specifically have human resources dedicated to water accounting. Moreover, despite this being introduced in the 1990s, Botswana in general and Ngamiland in particular still experience high rates (unaccounted water) of water supply especially from public standpipes which are not metered. Moreover, there has not much progress in ensuring that water supply for settlements such as Maun tallies with the rate of population growth and urbanisation. Water is still seen more as social good, making it challenging for service providers to provide the resource to households on a sustainable basis.

4.3. Institutions for water governance

The Ministry of Minerals, Energy and Water Resources (MMEWR) has the overall responsibility of coordinating developments and operational activities in the water sector. It mainly provides leadership and policy directions to the DWA and WUC by formulating, directing and coordinating overall national policies on water resources. Specific activities such as programmes and projects are carried out by the DWA and WUC.

Until 2009, water supply in Botswana was the responsibility of three institutions, namely WUC, which supplied water to cities and towns like Gaborone, Francistown and Jwaneng,

among others; DWA, which supplied water to large villages such as Maun Village; and the local authorities supplied water to small villages. Prior to April 2013, only DWA and the NWDC were the active participants in water supply in Ngamiland.

The two institutions which have been involved in water supply in Ngamiland, i.e. DWA and NWDC, worked independently as they fell under two different ministries of Minerals, Energy and Water Resources and Local Government, respectively. Though this was the case, infrastructure used by the NWDC was put in place by the former for operation and maintenance. This basically meant that there was a degree of dependence by NWDC on the DWA as it could not independently plan on its own the implementation of projects focusing on water infrastructure development. According to key informants from both DWA and NWDC, the two institutions were basically playing the same role of water supply. What differed were the areas in which they supplied water. Central government funded both institutions for the same function.

In some cases, DWA and NWDC had parallel infrastructure for water supply in the same locations. For example, both institutions managed separate boreholes along Thamalakane River and floodplain as well as separate transmission lines. Matlapana Village experienced a water supply problem since 2009; despite the fact that DWA was able to transmit some water through Matlapana to Maun Village. There were no arrangements by the two institutions to work together to ensure that Matlapana Village could get water from the DWA water supply system. The arrangement confused the people of Matlapana who could not understand why the DWA was able to get water from the area and supply Maun Village while they did not receive any water. The takeover of water supply by WUC has not rectified this issue as households from Matlapana continue to face water supply shortages.

The functions of both DWA and NWDC were negatively affected by the fact that funding from government was always tied to specific identified budget lines. They did not have the liberty to transfer funds from one budget line to another even if there was a critical problem. Thus, control of expenditure by the central government crippled water supply as DWA or NWDC could not quickly respond to situations which needed to be addressed urgently.

One of the major challenges faced by both DWA and NWDC was the theft of engines and diesel from boreholes. The situation disrupted water supply to villages (North West District

Council, 2008). All boreholes operated by DWA and NWDC which were taken over by WUC, are powered by diesel engines and as a result, require someone to physically go to each one of them to refuel and to undertake maintenance. During this process, those who are tasked with the duty of refuelling and carrying out maintenance occasionally put some diesel aside for their own personal use. WUC also encountered challenges related to ceasing of borehole engines and effects of floods on the operation of boreholes located on floodplains (North West District Council, 2010b). These challenges were also encountered by DWA and NWDC.

Water reforms, which commenced in 2009, identified the Water Utilities Corporation as the most appropriate institution to supply water to the more than 500 villages across Botswana. The reforms were aimed at separating water resources management from service delivery. As a result, WUC was handed the responsibility of service delivery and DWA became responsible for water resource management and planning. In order to reduce the number of institutions involved in water supply, district councils were relieved of this task. WUC started taking over water supply and distribution in all other districts in 2009, except for Ngamiland where it took over at the beginning of April 2013.

Households from gazetted settlements where WUC is mandated to supply water said that not much has changed in terms of water supply since the Corporation took over. All the households from the different settlement categories anticipated an improvement in water supply as a result of the takeover by WUC, but this did not immediately happen. In Matlapana, all households continue to experience acute water security problems as they do not have water supply from their main water sources. With regards to Somelo, WUC hauls water to the settlement since taking over the supply of water from NWDC. Households in Somelo complained that the hauled water was never adequate. They are always forced to be conservative in the use of water as the tanker which supplies them with water does not always turn up. In Ikoga, households reported that they still face regular water shortages since the takeover of water supply by WUC. In January and February 2014, households went for two weeks without any water supply and had to depend on water hauling.

A representative of WUC said that the water supply situation in the District remains critical, though there have been some improvements. According to WUC, Maun Village started receiving water for 24 hours a day after the completion of a 6,000 m^3 treatment plant installed

in the village and commissioned at the beginning of 2014. However, storage for the Village remains below expectation as this stands at 8,000 m^3 against a daily demand of 10,000 m^3. Treatment plants in the Okavango Sub-district which include villages of Mohembo East and Sepopa need to be upgraded to enable them to supply water to an increasing population. The Mohembo East Treatment Plant which was constructed in 1996 to supply Shakawe with a population of 3,298 then, but this has grown to more than 6,000. The plant further supplies water to 4 more gazetted and ungazetted villages like Ukusi, thereby raising demand and leading to frequent shortages (North West District Council, 2009, 2013). Moreover, both the Mohembo East and Sepopa Treatment Plants need to be installed with floculators to help in lengthening the lifespan of the sand used in the water filtration process.

The Corporation imports 50 tonnes of sand for use in the water filtration process in treatment plants from South Africa every 6 months at a total cost of USD300,000. According to the Ngamiland WUC General Manager, this is unsustainable. There are also costs related to diesel for borehole engines and for water hauling. The DWA which used to operate the boreholes, was spending an average of USD30,000 a month on diesel for the boreholes. A further USD20,000 each month was spent on running costs (i.e. fuel, tyres, maintenance and overtime for drivers) on 4 trucks used to haul water to communities in need of water when the water shortage was critical. When demand for water was lower, the DWA was spending an average of USD5,000 a month.

In terms of water quality, WUC argues that when it took over water supply, only 20% of the water in the district was of acceptable quality, but it has been able to improve to 70%. Though this is still below the required standards, which, for example, require that water supplied to households be free from any micro-biological contaminants, efforts are being made to ensure that only clean water is accessed by the households. Water quality for Maun Village is mainly affected by the fact that water has for some years been pumped straight into the system without prior treatment.

Across all the gazetted settlements, infrastructure for water, which includes transmission lines and storage tanks has not been properly maintained in the past. As a result, WUC is spending significant amounts of money on operations and maintenance.

One of the major challenges encountered by WUC is related to the absence of measuring devices on public standpipes. As a result, there is no information about how much water goes

out through each particular public standpipe in the district. Mainly because of this, WUC cannot adequately account for all the water supplied. DWA and NWDC did not install meters at public standpipes to monitor the amount of water accessed through such sources. WUC wants to convert all public standpipes into metered pre-paid standpipes so as to regulate the amount of water being used as well as to ensure that households pay for water once they exhaust their monthly free allocations. It is estimated that 45% of the water supplied by WUC is drawn through public standpipes, some of which are faulty and lose out water continuously. A total of 324 000 m^3 is supplied each month by WUC to households in the district and 145 800 m^3 cannot be accounted for[1].

[1]This was revealed by the WUC General Manager during an interview

4.4. Stakeholder participation

There is limited stakeholder participation in the management of water resources in Botswana, in general, and Ngamiland, in particular. There are no specific platforms and forums in both gazetted and ungazetted settlements where water issues, such as supply and distribution, are discussed by diverse groups of stakeholders, including households. Households pointed out that they are represented by ward councillors (81%), members of parliament (9%), village development committees (5%) and traditional leaders (5%) on water supply issues. Water issues, such as supply and quality in Ngamiland are usually discussed at council level by ward councillors, council officials and representatives from DWA and WUC. Issues discussed in council meetings include:

- Water supply shortages experienced in different settlements
- Flooding of boreholes along floodplains
- Inadequate funds allocated for private water connections in the district. As a result, in August 2009, the water connections backlog stood at 3,000 (North West District Council, 2009). In February 2010, a total of 1,041 private connections were made (North West District Council, 2010b).
- Inadequate funding for financing water supply in the district (North West District Council, 2009)
- Limited water storage for Maun Village. For example, in 2010, storage was 4,100 m^3 with a deficit of 12,538 m^3 that is required to achieve the 48 hour storage (North West District Council, 2010a).
- Increased developments in Maun Village, for example, houses and industries have increased the water demand in the Village (North West District Council, 2010a).
- NWDC's concern about DWA's inability to brief the council on the water situation in the district (Maun Administrative Authority, 2010).

The councillors are mandated to inform their wards on general development issues, including water supply issues discussed in council meetings. Sixty-three percent (63%) of the households across all the settlements highlighted that their representatives on water supply and quality issues have not been effective given the water insecurity which they frequently encounter.

All of the households are not given an opportunity to play a direct role in water management, in general and water supply, in particular. This is mainly due to the absence of stakeholder platforms for water management. Eighty-seven percent (87%) of the households said that they can play a role in water supply in the district, especially in giving their service providers advice on how water supply can be done. Though councillors mainly represent households in water supply and quality issues, 87% of the households have never been consulted on issues related to water supply by either the DWA, NWDC or WUC.

During some of the village development meetings where various issues are discussed, including water, officials from DWA and NWDC are invited to discuss water issues with the communities. After the takeover of water supply by WUC, officials from the corporation get invited to discuss water issues with the communities. Households usually raise concerns about prolonged water shortages, billing and water payments at such meetings.

Households highlighted that they are not consulted much with regards to water supply. Even when it comes to the setting up of water charges, they have no knowledge about how this is done. Ninety-one percent (91%) of the households hold the view that water charges are set by DWA while 6% believe it is the district council and 3% said it is the central government.

Though formal platforms for stakeholder participation in water resource management are absent in Ngamiland, households from most settlements have not been able to show initiative to be involved in water management. This is evidenced by the state of public taps which are not well maintained in most settlements. Since households do not have structures for maintaining public standpipes in their settlements, most of them are not functional. Most public standpipes are not protected and, as a result, they can be easily damaged by livestock and children leading to leakages which lead to pools of water developing around them. Households from all the settlements with non-functional public standpipes expect their service providers to do all the repairs whenever there is a problem with the standpipes. This is regardless of how minor the problem can be. Only households in Ukusi, an ungazetted village, managed to protect their public standpipes by fencing around with tree logs and wire.

4.5. Water payments

Sixty-two percent (62%) of households from gazetted settlements pay for the water that they use for domestic purposes. Of the 62% households paying for water, 56% are from Maun

Village. There is a statistical association between settlement and payment for water (Pearson's chi-square test value = 387.4054, degrees of freedom = 7, p=0.000), at 5% significant level. Households across the different settlement categories pay an average of USD3.5 per month for the water that they use. The majority of households in the other settlements are either not paying for water or they access water from public standpipes for free. All the public standpipes do not have meters, and as a result, water accessed from such sources is not accounted for. Officials from NWDC, DWA and WUC feel that water is being misused by households at public standpipes as some is actually used to water livestock while some of the standpipes are not maintained, leading to leakages. This prompted WUC to consider installing pre-paid water meters which will record how much water is being used from each public standpipe and also to bill households for water from these points.

Households in Maun Village complained about paying for water despite the fact that they go for prolonged periods of time without any water supply. By the time DWA handed over water supply to WUC, disconnections were being effected to force households to make payments. WUC continued with the disconnections and this compelled most households that were defaulting to start clearing their arrears while other households were encouraged to pay, fearing disconnections. In settlements such as Matlapana where most households have not been receiving water since 2009, the majority of the households with private water connections do not pay for the water that they use for domestic purposes.

DWA and NWDC were not very efficient in the collection of revenue, a situation which led them to be owed huge sums of money by the residents. The NWDC Water Unit officials highlighted that they were collecting 20% of what they were supposed to be collecting from households with private connections. The situation was made worse by councillors who always resisted water disconnections as this was detrimental to their political careers.

Fifty-seven percent (57%) of the households that are paying for water said that they are not satisfied with the payments. There is a statistical association between payment of water and satisfaction by households (Pearson's chi-square, degrees of freedom = 7, p=0.000), significant at 5% level. The reasons for being dissatisfied include high water charges, unjustified charges and lack of regular supply. They feel that water should be provided to them for free.

5. Discussion

The lack of efficient water governance at the global, continental, national and local levels significantly constrains and jeopardises water security as well as current and future social and economic development of the world (Pahl-Wostl et al., 2008). Developed countries have been able to put in place water governance structures that have, to a greater extent, enhanced water security. There is, however, need for them to constantly review their approaches given challenges in freshwater availability due to factors such as climate change (UNDP, 2006). Developing countries require the formulation and implementation of more efficient water governance policies and practices that enhance water security on a sustainable basis.

Good water governance is, thus based on principles of good governance, which include equity, efficiency, participation, decentralization, integration, transparency and accountability (African Development Bank, 2013; Kaufmann, 2004). These principles should not be treated in isolation and must not be seen as an end in themselves but a means to an end, that is, water security. The above principles of water governance are underpinned by various elements (Table 3) of good water governance which would ideally play a critical role in enhancing water security if applied appropriately in a holistic manner.

Table 3: Elements of good water governance

Governance element	Contribution to Water Governance
Appropriate policies and legislation	To underpin effective water governance
Effective service delivery	Capacity of local government/utilities in managing, and maintaining water supply and sanitation (WSS) service delivery.
Revenue mobilization and public financial management	Financing WSS service provision at national and local levels.
Conducive conditions for private sector investment	Policies, legislation, regulations and incentives for private sector participation in WSS service delivery.
Political participation and checks & balances	Strengthening consumer/user voice to enhance accountability for WSS services.
Transparency and media	Improving access to information on WSS rights, access, planning, budgeting and expenditures.
Judiciary and rule of law	Ensuring water rights and providing for recourse, arbitration, conflict resolution and appeal.
Civil society participation	Support sectoral social accountability mechanisms to ensure effective service provision.
Respecting human rights	Process of articulating, agreeing, implementing and monitoring the fulfilment of rights to WSS.
Pro-poor policies	Water service delivery approaches responding to increasing demand from poor households for adequate and affordable services.
Enhancing gender equity	Gender-based approaches to service delivery, women's participation in user groups and decision-making bodies; gender-disaggregated data.

Governance element	Contribution to Water Governance
Proper regulatory mechanisms	Regulatory environment that encourages pro-poor service delivery and minimum standards for water services while combating water pollution.
Corruption and integrity	Tackling misallocation and diversion of resources intended for WSS service delivery improvements.

Source: African Development Bank, 2013

Apart from being a semi-arid country with limited freshwater resource, Botswana has also a water governance crisis which is a reflection of the failure of effective and efficient water governance at the global level in general and in developing countries in particular (Gupta, 2011; Kujinga, et al, 2014a; 2014b). Water governance in Botswana has not been able to guarantee household water security as evidenced by the extent of water insecurity experienced in Ngamiland (Kgomotso & Swatuk, 2006; Kujinga, et al 2014). Such water insecurity is experienced in much of the developing world despite the existence of some water governance structures (Fishman, 2011).

In terms of water policy, Botswana can be commended for deliberately adopting and pursuing a policy which aims at enhancing access to water for all households in gazetted settlements through improved sources (Kgomotso & Swatuk, 2006; K Kujinga et al., 2014; Swatuk & Kgomotso, 2007). However, this policy is rendered ineffective in practice as households fail to access water on a sustainable basis from their improved sources due to shortages experienced periodically. Water policy in Botswana and other developing countries where there is water insecurity, need to focus on strategies which emphasize on good water governance that enhance sustainable water supply for households (Kujinga et al., 2014). Few countries in Africa, such as Egypt, Namibia and South Africa, have been able to adopt and implement policies which enhance access to improved water sources (UNICEF/WHO, 2008). However, the presence of improved water sources alone has not been able to ensure reliable access to water as some of these sources go for prolonged periods of time without supplying water due to poor water governance.

Botswana's water policy excludes households from other settlements (i.e. ungazetted) from receiving any water supply despite the fact that water is a basic need (Savenije, 2002). Ungazetted settlements in Botswana do not receive water supply services mainly because they are informal as they, in most cases, just mushroom without any proper planning. However, the same settlements are expected to take part in other processes such as elections and livestock production. Good water governance needs to be inclusive rather than exclusive. Botswana has to change its policy and ensure that households in settlements categorised as ungazetted receive potable water supply since water is essential for sustaining life. If Botswana puts in place a new policy which recognises ungazetted villages, it is important to note that challenges in water supply in most of these settlements will be encountered since most of them are scattered and located in remote areas. There will be a need for the country to come up with an innovative approach to water supply for the scattered and remote settlements. While those existing ungazetted settlements can be formalised, it is important for the country to put in place stringent measures which curb the further mushrooming of ungazetted settlements. Those who set up such settlements can be liable to prosecution and their structures demolished by the state.

The adoption of water accounts by Botswana should be seen as a positive step as this has the potential of improving water governance. It is therefore important for Botswana to make this process so that it can provide information that can improve water governance. There is need for the country to put more financial, material and human resources in water accounting to enable data to be collected at the lowest appropriate level rather than have this centralised in Gaborone.

Water legislation in Botswana needs to be revisited so that it can be brought in line with current water management approaches such as IWRM that are meant to enhance water governance, in general, and address water insecurity, in particular (GWP, 2000a). A number of countries which include Zimbabwe, South Africa, Tanzania and Malawi have reformed their water legislation frameworks and brought them in line with the IWRM paradigm (Kujinga & Manzungu, 2004). Though IWRM can be challenging in operationalising, its principles of equity, stakeholder participation and efficiency are critical for water governance and household water security.

The of lack of resilient water management institutions which can manage scarcity and water related risks (such as floods and natural disasters) in developing countries has been identified as being behind ineffective water governance which greatly contributes to global water insecurity (Harris et al., 2013). Though a lot needs to be done in strengthening institutions for water governance in Botswana, the country took a positive step by having water supply in each district managed by one water supply institution. The multiplicity of institutions responsible for water supply in one district creates confusion and conflicts between and among the institutions involved as was previously the case in Ngamiland (Huitema et al., 2009). However, the WUC which took over water supply in Ngamiland, needs to ensure access to water for households on a sustainable basis, including those in ungazetted settlements. Water institutions play a critical role in water governance as they are the ones with the role of ensuring adequate water supply to households (Saravanan, 2008). For water governance to be effective, countries have to consolidate responsibilities of institutions tasked with water management, clarify their roles, and eliminate overlapping functions (GWP, 2000a).

Current approaches to water governance, such as IWRM, emphasise the need to involve all stakeholders, including users, in the management of the resource (Dungumaro & Madulu, 2003; Jonsson, 2005; Kujinga, 2002; Kujinga & Manzungu, 2004). Countries such as Zimbabwe and South Africa have provisions for stakeholder participation in their legislations (Kujinga & Manzungu, 2004). Zimbabwe's water legislation has provisions for sub-catchment councils as well as catchment councils while the South African legislation has a provision for catchment management agencies whose main role is to represent the interests of various stakeholders in the management of water resources (Kujinga, 2002). Stakeholder participation as well as platforms for stakeholders to interact within the water sector in Botswana are lacking as the country's legislation does not provide for such platforms.

Water is a special good for which there is no substitute (Savenije, 2002) and, as a result, its pricing should not be left to market forces to determine as this disadvantages the poor (Vanderzaag & Savenije, 2006). Though the price of water should not be determined by the market like what is currently happening in Botswana, the resource should have a price in order to recover the cost of providing it and giving a clear signal to the users that water is indeed a scarce good that should be used wisely (Vanderzaag & Savenije, 2006). If households in countries such as Botswana were to pay the full cost of water supply, most

households would not afford. Water supply in Botswana is both undervalued and heavily subsidised. WUC uses a block tariff system which enables low consumers to pay less while higher consumers pay more (Hambira et al., 2011). This approach promotes efficient use of water as households always endeavour to consume less water. There is need for WUC to ensure sustainable supply of water to households in different settlements. However, sustainable supply of water might require households to pay the full cost of the water, something which the majority of the households will not be able to do. In settlements where households currently access water from public standpipes for free, there is need for WUC to put in place measures that will enable the collection of revenue as this will curb the unsustainable use of water. This will also enable households to appreciate the value of water.

Proper valuation or pricing and efficient revenue collection has the potential of enhancing water governance if the collected resources are reinvested in water supply. In most cases, households are willing to pay for reliable water supply as well as water of good quality. Households become concerned when they do not have a reliable water supply of good quality and are required to pay water charges at the same time (Vásquez et al., 2009). The fact that the majority of households in Maun Village pay for the water that they use shows that, to some extent, they regard water as an economic good.

Water governance institutions need to be free from political interference as this hampers their smooth functioning. Politicians need to be reminded that if services such as water are not paid for by the users, it would be a difficult to sustain the delivery of such a service. Water governance can be improved through the establishment of autonomous water management institutions which have to collect and control their revenue and also invest the revenue in water management and supply. In most African countries, there are semi-autonomous water management institutions as most of them are quasi government institutions whose operations are to some extent controlled by the state. Most of the water supply institutions do not have the liberty to increase water charges without government approval. This makes it difficult for these institutions to provide reliable water to households.

6. Conclusion

There is currently a global water governance crisis which is contributing to household water insecurity in developing countries. Poor water governance in Botswana has resulted in households going for prolonged periods of time without reliable water supply despite the fact

that the majority of households have access to improved water sources. This ineffective water governance in Botswana is a reflection of the situation at the global level.

There is need for countries such as Botswana to adopt strategies that promote good water governance, something which will have a positive impact on household water security. Botswana has to come up with a legal framework which upholds current water management approaches such as IWRM to enhance good water governance through equity, participation, coordination, sustainable development, and inclusiveness. There is need for IWRM to be underpinned by a legal framework as well as policy and strategizes aimed at operationalising the approach.

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CHAPTER SEVEN

Household water security – A synthesis

7. Overview

The thesis has shown that at the global level, water security is threatened by complex factors that include hydrological conditions, rapid population growth, rural-urban migration, increased per-capita water use, pollution of water resources, over-abstraction of groundwater and climate change and variability (Evengard et al., 2011; GWP, 2000; Jones et al., 2009; Vörösmarty et al., 2010). Despite policies and programmes put in place to enhance water security at the global level by the international community (e.g. the United Nations and the G8), 783 million people still lack access to clean and safe water (Omara & Eltawil, 2013). Water insecurity is mainly affecting Africa and Asia where a significant number of the population lack access to safe and clean water (Cosgrove & Rijsberman, 2014; Gleick & Heberger, 2014). Water insecurity in Africa is partly a result of large parts of the continent that are significantly arid or water scarce, where the spatial and temporal distribution of surface water is mainly influenced by the interplay between sparse and erratic rainfall and high evaporation rates (Grey & Sadoff, 2007). In countries that receive adequate rainfall, such as the Democratic Republic of Congo, poor water governance is the major contributor to water insecurity (African Economic Outlook, 2013).

The world is currently confronted with the need to enhance water security as highlighted under the Millennium Development Goal 7, Target 10 which aims at halving the number of people without sustainable access to safe drinking water by 2015 (UN, 2013). Despite efforts implemented since the MDGs were put in place, Southern Africa is equally affected by water insecurity in general, and household water insecurity, in particular, as an estimated 100 million people do not have access to safe drinking water (SADC, 2012). Households are encountering challenges in accessing water for drinking, cooking, general cleaning and sanitation. The attainment of this goal will not be achieved by the end of 2015 in Africa in general and Southern Africa in particular. The Sustainable Development Goals SDGs) which succeeded the MDGs also put an emphasis on access to clean water and sanitation under goal 6, Target 6.1 by emphasizing that safe drinking water should be measured both in terms of water quality and safe access to the water supply (International Council for Science, 2015). The attainment of other SDGs goals such as goal 1, to end poverty in all its forms; goal 2, end hunger and achieve improved nutrition and promote sustainable agriculture and goal 3,

ensure healthy lives and promote well-being for all ages, hinges on access to clean and safe water (International Council for Science, 2015). This thesis has explored household water security in different settlement categories of Ngamiland, Botswana. This last chapter synthesises the findings. The thesis has been underpinned by the concepts of security, water security, human security as well as the actor-oriented approach, the concept of governance and the IWRM approach. Security has been defined in this study as entailing freedom or protection from serious risk and threats to human wellbeing (Soroos, 1994). The study used the broadened concept of security to include other referent objects (other than the state as traditionally applied) which include households and their members who need water security on a daily basis (Buzan, 1983; 1991; Buzan, Weaver, & de Wilde, 1998; Paris, 2001; UNDP, 2006). Focus was on human security in general and water security of households and their individual members, in particular. As noted in the thesis, in enhancing water security, there is need for countries to emphasize accessibility to water of adequate quantity and good quality at affordable cost (Cook & Bakker, 2012; Grey & Sadoff, 2007; GWP, 2000; Lautze & Manthrithilake, 2012; Vörösmarty et al., 2010; Webb & Iskandarani, 1998; Zeitoun, 2011). This will safeguard human security from critical pervasive threats of water insecurity in a way that is consistent with long term human fulfilment (Alkire, 2003). Water insecurity is a pervasive threat which can threaten the core of human lives since water is essential to human survival and has no substitute (UNDP, 2006).

This thesis has shown that 74% of households across the different settlement categories in Ngamiland are experiencing serious or acute water insecurity. This water insecurity poses an existential threat to the survival of households and their members (Buzan et al., 1998). In Ngamiland, water insecurity manifests itself through frequent unavailability and inaccessibility of enough water of good quality to meet domestic needs of households in different settlement categories. Households from gazetted settlements go for prolonged periods of time without water despite the fact that they have improved water sources, while those from ungazetted settlements do not receive any water supply services. On the other hand, the quality of water accessed by households from both gazetted and ungazetted settlements is sometimes of poor quality as it has some micro-biological contaminants.

The thesis, through the use of the actor-oriented approach, has shown that in the context of water insecurity, households and their individual members become active actors in devising coping strategies and, to a lesser extent, adaptation strategies to this phenomenon.

Households from different settlement categories of Ngamiland have, to some extent, the agency to cope with water insecurity through different strategies highlighted in Chapter Four. The most active actors identified are women of different age groups as well as girls and children who have to ensure water availability for households during times of water insecurity.

The thesis has shown in Chapters 2 – 6 that the household water insecurity experienced in different settlement categories of Ngamiland is linked to poor water governance. Good water governance has to be anchored by an appropriate legal framework and policy provisions as well as effective water management institutions (Parl-Wostl et al., 2010). Good and effective water governance elements are lacking in Botswana and this could be linked to an outdated legislation and lack of a water policy though one is being crafted. Both policy and legislation has to spell out the need for ensuring domestic water supply from surface water or groundwater water sources even within water scarce contexts, such as Ngamiland, as well as highlighting issues related to water pricing and stakeholder participation. The hydrology of Botswana in general and Ngamiland in particular can best be described as "difficult" as it is characterised by low precipitation and run-off on one end and period flooding at the other end (Grey and Sadoff, 2007). Such a situation should have motivated water governance planning in Botswana and Ngamiland Botswana to learn from areas such as South Australia which have been able to enhance household water security until 2050 through the Water for Good Plan despite the fact that the area is water scarce (Government of South Australia, 2009). The Water for Good plan of South Australia spells out how household water security can be ensured in a water scarce environment through various strategies such as appropriate legislation and institutional arrangements, water pricing, desalination of ocean water, storm water harvesting, wastewater recycling, artificial aquifer recharge, rainwater harvesting and use of water serving devices at the household level (Government of South Australia, 2009).

The thesis has demonstrated that poor water governance is a major factor behind household water insecurity in Ngamiland as evidenced by the fact that infrastructure is available but the relevant water supply institutions are unable to supply households with water of good quality from the Okavango River and its associated tributaries as well as from underground. The Water Utilities Corporation and previously the Department of Water Affairs and the North West District Council have been unable to ensure that water supply infrastructure (i.e. boreholes and treatment plants) is well protected from flooding in order to ensure that

households continue receiving water even during periods of extreme events. Moreover, proper water governance would have seen the water supply institutions shifting from the reliance of human labour in the operation and maintenance of boreholes to more advanced technologies such as telemetry. Unlike in South Australia, there has not been future planning for water supply for settlements such as Maun Village with regards to population growth and urbanisation. This planning has to take into consideration population growth, urbanisation as well as the lifespan of water supply infrastructure.

The adoption of water accounts by Botswana should be seen as a positive step as this has the potential of improving water governance and ultimately water security. It is therefore important for Botswana to make this process so that it can provide information that can improve water governance. There is need for the country to put more financial, material and human resources in water accounting to enable data to be collected at the lowest appropriate level rather than have this centralised in Gaborone.

7.1. Major Findings

In the following sub-sections, the major findings of this thesis are summarised.

7.1.1. Household water security challenges in different settlement categories of Ngamiland, Botswana (Chapter 2)

Chapter Two of this thesis has demonstrated that there is serious household water insecurity across all the different settlement categories of Ngamiland. With regards to Maun Village, the only primary center in the district, 57% of the households trace water insecurity to the period between 2005 and 2009. During this period, households would sometimes go for up to 24 hours without any water supply. As from 2009, the frequency of water shortages started increasing to 3 days or more. Primary center households (73%) identified June 2011 to June 2012 as being the worst period in terms of water supply. In some instances, households went for a month without water supply services.

Tertiary settlements in Ngamiland, (that is. Ikoga, Somelo and Matlapana), experience frequent water supply shortages. Between 2005 and May 2011, 67% of tertiary center households experienced water supply shortages. Water shortages in tertiary settlements worsened as 94% of the households did not receive reliable water supply between June 2011

and June 2012. At the time of the survey, 70% of tertiary center households were not receiving any water supply services.

Ungazetted settlement households from Gucha, Samedupi and Xobe do not receive water supply services mainly as a result of policy provisions which exclude such settlements from the provision of social services, including water supply. As a result, the households mostly access untreated water (from perennial rivers and seasonal streams) of poor quality. However, there have been contradictions in policy implementation as some ungazetted settlements such as Ukusi are supplied with water for domestic purposes through public standpipes, making the households in such settlements relatively water secure as compared to the other households.

In terms of water quality, micro-biological tests conducted show that water from different sources across all the different settlement categories is not suitable for drinking. Water from both protected sources and unprotected sources contains some microbiological contaminants. This shows that the mere presence of protected water sources does not mean that the water is of good quality.

7.1.2. Factors contributing to household water security problems and threats (Chapter 3)

Chapter Three discussed factors that are contributing to water insecurity in different settlement categories of Ngamiland. Multiple factors, which include the Government of Botswana's settlement policy, climatic and hydrological factors, technical, socio-economic and financial factors, interact to cause water insecurity in different settlement categories of Ngamiland.

The chapter has revealed that the Government of Botswana's policy on settlements plays a major role in household water security as the status of a particular settlement determines whether or not it receives critical services, including water supply. Households from settlements designated as gazetted (e.g. Maun Village, Matlapana, Ikoga and Somelo) receive water supply services through improved water sources which include public standpipes and private connections. Within each gazetted settlement, residents are not supposed to walk more than 400 m to a water source (Swatuk and Kgomotso 2007). Public standpipes are supposed to be ideally placed within a distance of 250 m. On the other hand, settlements

categorized as ungazetted (e.g. Gucha, Ukusi, Samedupi and Xobe), are not supposed to receive water supply services due to their status as defined by the Government of Botswana settlement policy. As a result, households from such settlements mainly access water from unprotected sources for domestic purposes. Thus, there is a lack of equity in terms of provision of social services, in general, and water supply, in particular, between gazetted and ungazetted settlements.

Climatic and hydrological factors greatly contribute to household water insecurity in different settlement categories in Ngamiland. Rainfall in the district is limited, erratic and highly variable as it ranges from 450 mm to 600 mm annually. Evapo-transpiration rates in the district are very high (in excess of 1700 mm/year). Surface water resources in the district are limited as they are only found in the Okavango Delta from which 96% of the combined 10,000 Mm^3/a inflow and 5000 Mm^3/a rainfall evaporate (HOORC, 2007). A combination of porous geology, highly permeable Kalahari sands and overall low rainfall make it impossible for the area to have dams which can be used to store and supply water to households in different settlement categories (Mukuhlani & Nyamupingidza, 2014). Moreover, the majority of the settlements in Ngamiland mainly depend on groundwater for domestic purposes, but this is now limited and most of it is saline.

Extreme events such as floods have had a negative impact on water sources which supply Maun Village, Matlapana, Somelo and Ikoga, thereby contributing to household water insecurity. Most of the boreholes operated by DWA, NWDC and now by the WUC are all located along the different channels of the Okavango Delta and this makes them prone to submerging by floods. Between 2009 and 2011, 16 boreholes (located along Kunyere, Thamalakane and Shashe floodplains) operated by DWA and NWDC's four boreholes which supplied Matlapana and Somelo villages were all submerged by floods during that period.

As highlighted in Chapter Three, several technical factors contribute to water insecurity in gazetted settlements. There is reliance on human labour in the operation and maintenance of boreholes which are all located along river channels. Personnel have to physically go to the boreholes on a daily basis to fuel them or to carry out some maintenance work. If this is not done, the boreholes will not be able to function properly. Human labour can be hindered by floods which make the location of some boreholes inaccessible. Specialized equipment acquired by DWA (i.e. the hippo and amphibian) to enable its personnel to reach boreholes

during times of flooding and muddy periods, constantly breaks down. Other technical factors experienced in the supply of water to gazetted settlements include electric power cuts which negatively affect the operation of surface water treatment plants which supply water to Ikoga and Ukusi villages. The power cuts usually last for up to nine hours and there could be up to six power cuts a month. Surface water treatment plants also need granular sand for the slow sand filtration system to filter the water. The granular sand is not available in the district and this results in the use of fine sand which slows the filtration process and blocks the filters. The process of unblocking the filters can take a day or more and this results in households not having access to water during such times.

Reliable water supply in Ngamiland over the years has been constrained by limited financial resources on the part of DWA and NWDC. Funding for water supply in the district has been inadequate as budgets have been cut since 2009. As a result, there have not been many new projects between 2009 and 2014. Both NWDC and DWA concentrated on the operation and maintenance of the available infrastructure.

It is vital to note that domestic water in Botswana is supplied more as a social good than an economic one (Kgomotso & Swatuk, 2006). Households accessing water from public standpipes do not pay for the water they use as there are no devises installed to record the amount of water being accessed. Those with private standpipes pay nominal fees. As a result, it becomes challenging for the service providers to provide a reliable service.

In terms of governance, the study has shown that Botswana still uses a number of old legal frameworks for the management of water resources which are not integrated. The different old pieces of legislation include the Borehole Act of 1956, the Water Act of 1968, the Waterworks Act of 1962, amended in 1983 and the Water Utilities Corporation Act of 1970, amended in 1978. These pieces of legislation are neither integrated nor enforced. The Water Act of 1968 does not capture current developments and principles of water resource management such as integrated water resources management (IWRM) which has the potential of enhancing water security.

Socio-economic factors have also contributed to water insecurity, especially in Maun Village, the only primary center in the district. These factors include population growth in Maun Village which is not being matched with the available water supply and urbanisation. The

population of Maun Village grew significantly between 1971 and 2011, from 9,614 to 60,260 (Central Statistics Office, 2011). According to the 2011 census results, Maun Village has 38% of Ngamiland's population (Central Statistics Office, 2011). This growth has not been matched with improvements in water supply infrastructure.

Maun Village as the capital of the North-West District has assumed a more urban character over the years. It has experienced developments such as more residential centers, shopping malls, hotels, lodges, schools, health centers and expansion of the airport, all of which have put pressure on water supply and the available infrastructure. The district is also the hub of Botswana's tourism industry.

Chapter Three has further demonstrated that primary centers like Maun Village grapple with problems of water storage capacity, poor water distribution network as well as increased demand for individual connections. All these challenges contribute greatly to household water insecurity. Maun Village does not have adequate water storage facilities. Water storage facilities for Maun Village are able to store 5,365 m^3 against a daily demand of 8,319m^3. DWA has been able to supply 7,830 m^3 /day. This means that in the event of a breakdown of boreholes or treatment plants, the settlement has inadequate water storage facilities to provide households with water while any supply problems are being attended to. The desired water storage facility capacity for Maun Village is 16,638 m^3. This problem is made worse by the fact that the water distribution network of Maun Village is not efficient as it is unable to cope with demand due to its layout and age. The network is more than 30 years old and has not been upgraded. It was designed for a small population of around 14,925 but now it caters for more than 60,000 people as well as several businesses (e.g. hotels) and institutions (e.g. schools and higher education institutions) which require water on a daily basis. The network experiences frequent pipe bursts resulting in households going for days without water supply. As a result, it is estimated to lose more than 25% of the water on a daily basis. Moreover, the network does not cover 32% of Maun. The network is complex because of the poor layout of most of the residential stands in Maun Village which do not follow a well-planned format and standard.

Primary center households in Maun Village and tertiary center settlements like Matlapana have been experiencing an increase in the number of private water connections since the turn of the century, particularly between 2000 and 2012. An increase in private connections is

usually accompanied by an increase in household water consumption. This usually results in increased demand of water by households, leading to service providers being unable to cope with demand in an environment like Ngamiland where water delivery is already problematic.

7.1.3. Short and long term strategies for household water insecurity in Ngamiland, Botswana (Chapter 4)

In Chapter Four, it was demonstrated that when households face water insecurity, they are not passive actors but actively devise coping or adaptation strategies aimed at ensuring household water availability. In ensuring water availability at the household level through the use of different coping or adaptation strategies, the actors will be enhancing household water security (GWP, 2000).

Households respond to water shortages through coping strategies (short-term) as opposed to adaptation (long term) strategies. This is mainly because the majority of households lack financial and material resources needed to invest in adaptation strategies. Little or no financial resources are required in employing coping strategies to water shortages. Coping strategies mainly used by households in different settlement categories include fetching of untreated water from perennial rivers such as Thamalakane for Maun Village and Matlapana households, Boteti River for Samedupi and Xobe households, Ikoga River for Ikoga Village, Okavango River for Ukusi Village and Kwenokoore stream for Gucha Village.

Households in gazetted settlements also cope with water insecurity by fetching water from neighbours' standpipes. In cases where there are financial implications, households with running water from their private standpipes ask their neighbours to pay for the service.

Households that own light vehicles use these to transport water from where it is available. This strategy is used by 16% of the households across all the different settlement categories. Some households which do not own light vehicles, but have access to vehicles either from their work places, friends, neighbours or hired ones, also use these to transport water to their households.

It has also been observed in this study that households that are economically well off, especially those from Maun Village and Matlapana, are able to purchase water from a bulk

water supply market that emerged in Maun Village due to water insecurity since 2000. Bulk water is bought in different quantities between 2 m^3 to 10 m^3 and offloaded in storage tanks at the respective households' premises. On the other hand, the state, through the Department of Water Affairs and the North West District Council, supplied bulk water to selected settlements which include Ikoga, Maun Village, Matlapana and Ukusi during periods of water shortages. Bulk water was off loaded in centrally located storage tanks from where household members access it. DWA and NWDC could not sustain bulk water hauling to households of Matlapana and Maun Village and this had to be discontinued despite the fact that households in these settlements still face water insecurity. The WUC has continued with bulk water hauling to Somelo and Ikoga villages. However, in most cases, the bulk water supplied by the state institutions is usually inadequate for all the households in each particular settlement.

Rainwater harvesting is one of the most common practices adopted by 63% of households across the different settlement categories. Analysis of the results revealed a strong statistical association between water shortages and the practice of rainwater harvesting (Pearson's chi-square value = 25.6292, degrees of freedom = 7, p = 0.001), significant at 5% level. The majority of the households are able to use agency to use simple rainwater harvesting techniques such as placing containers below their roofs and this plays a critical role in ensuring household water availability. More than 200 L of rain water can be harvested from one rainy event.

Other coping strategies used by households to ensure their water availability include prioritizing water use during times of shortages. For example, households (100%) prioritise drinking and cooking during times of shortages. Bathing and laundry usually get the least preference when water insecurity becomes acute. Almost all the households (97%) across the different settlement categories store water in containers of different sizes (20 L or 25 L) for current and future use. In cases where households have supply from their improved sources, they usually have some containers filled with water for use when there is no supply.

In terms of adaptation strategies, these are used by a few households (2%) whose monthly income is at least BWP10,000.00 Adaptation strategies to water insecurity by households include the drilling of boreholes or well points, rainwater harvesting using proper equipment

and connecting storage tanks to main water systems which fill the tanks when water is available for use when there is no supply.

7.1.4. Analysis of gender and other social dimensions of household water insecurity (Chapter 5)

Chapter Five analysed the impact of water insecurity on men, women and children from different settlement categories of Ngamiland. The chapter showed that women and girls physically bear the burden of water insecurity through spending prolonged periods of time fetching water which they carry in containers loaded on their heads. In addition, there are other social dimensions to water insecurity such as the use of various assets, rainwater harvesting, personal hygiene and the inter-personal politics of fetching water from neighbours' standpipes.

During periods of water insecurity, women and girls (10 to 17 years) (96%) across all the different settlement categories, are mainly responsible for ensuring household water availability. Water for household use is usually fetched from untreated sources, mainly rivers, using 20 L or larger containers which are head-loaded to the homestead. Women from different settlement categories of Ngamiland spend an average of 68 minutes on a daily basis fetching water for household use. Fetching water by women has a high opportunity cost as they forego other productive activities such as farming in order to ensure water availability in the household. Women also encounter difficulties in balancing time for other domestic activities, children and the biological needs of their spouses.

Chapter Five has demonstrated that water insecurity generates differential patterns of responses (heterogeneity) in terms of the assets used to transport water by men and women based on gender and socio-economic status (Long & Van der Ploeg, 1994). The most common assets used by women, girls and children when fetching water are 20 L and 25 L plastic containers. Frequent head-loading of water containers by women has health implications as it results in neck and back pain. The situation is exacerbated when one is pregnant or carrying a child on the back.

In situations where men assist in fetching water, they usually use donkey drawn carts while households which are economically well-off, use light vehicles. Where this is the practice, it allows the household to transport up to 0.5 m^3 of water or more on a single trip. This goes a

long way in relieving pressure on women from fetching water on a daily basis. However, in cases where the donkey-drawn carts or the light vehicles are not available, men refrain from fetching water, thereby placing a heavy burden on women who have to head-load some containers of water to the homestead.

Chapter Five has further showed that rainwater harvesting using the simple technique of placing open containers below rooftops is mainly done by women who are, in some cases, able to harvest 200 L of water from one rainy event. This allows women to reduce the number of trips which they undertake to other water sources during the rainy season. In cases where households have proper rainwater harvesting equipment, such as roof gutters and storage tanks (of 5,000 L or 10,000 L), the households can capture adequate water which can last until the following rainy season, thereby helping women to reduce the number of trips to other water sources using plastic containers which they have to head-load.

It has also been shown in this chapter that members from different households value personal hygiene, especially bathing, but this is usually negatively affected by lack of or inadequate water. This results in household members, both men and women, reducing the frequency of bathing per day, the amount of water used for bathing or not bathing at all. In 72% of the households, water availability determines whether household members have to bath. There is a statistical association between water availability in the household and bathing (Pearson's chi-square value = 34.5601, degree of freedom = 7, p = 0.000), significant at 5% level.

Water insecurity has the potential to cause conflicts among household members across all the different settlement categories. Across all the settlement categories, 61% of the household members have misunderstandings related to water usage, amount used and purpose of use. Most of the conflicts are verbal in nature. There is a statistical association between water shortages and misunderstandings between and among household members (Pearson's chi-square test value = 113.5930, degrees of freedom = 7, p=0.000), highly significant at 5% level.

7.1.5. Water governance and household water security in Botswana (Chapter Six)

Chapter Six analysed water governance approaches being used in Botswana, in general, and Ngamiland, in particular, and their implications on household water security. Water governance approaches being used in Botswana are not enhancing water security as a result

of inappropriate legislation which does not take into consideration current water management approaches like IWRM. It is recommended that the Government of Botswana reforms its water legislation so that it can be in line with water management approaches which are capable of enhancing water security for households. Moreover, there is need for the country to have one piece of legislation which focuses on both surface and groundwater resources since the two are connected.

If Botswana is to make progress towards the achievement of water security, it is important for the countries to adopt the principles of good governance, which include equity, efficiency, participation, decentralization, integration, transparency and accountability (African Development Bank, 2013; Kaufmann, 2004). These principles should not be treated in isolation and must not be seen as an end in themselves but a means to an end, that is, water security. The above principles of water governance are underpinned by various elements good water governance which would ideally play a critical role in enhancing water security if applied appropriately in a holistic manner.

The Ministry of Minerals, Energy and Water Resources (MMEWR) has the overall responsibility of coordinating development and operational activities in the water sector. It mainly provides leadership and policy directions to DWA and WUC by formulating, directing and coordinating overall national policies on water resources. Specific activities such as programmes and projects are carried out by DWA and WUC. Until 2009, water supply in Botswana was the responsibility of three institutions, namely WUC, which supplied water to cities and towns, e.g. Gaborone, Francistown and Jwaneng; DWA, which supplied water to large villages such as Maun Village; and the local authorities which supplied water to small villages. Prior to April 2013, only DWA supplied Maun Village while the NWDC was responsible for water supply to tertiary villages in the district. The WUC took over the supply of water to all the gazetted settlements of Ngamiland on the 1st April 2013. However, this did not immediately translate to reliable supply of water for households.

In this chapter, it was revealed that there is limited stakeholder participation in the management of water resources in Botswana, in general, and Ngamiland in particular. There are no specific platforms and forums in both gazetted and ungazetted settlements where water issues such as supply and distribution are discussed by diverse groups of stakeholders, including households. This is despite the fact that Botswana as a country subscribes to the

principles of IWRM. If stakeholder participation is to be institutionalised and made meaningful in Botswana, there is need for legislation which will underpin stakeholder participation. In contrast, in the neighbouring countries of South Africa and Zimbabwe, stakeholder participation through specific water management institutions is underpinned by both policy and legislation (Kujinga & Jonker, 2006; Kujinga & Manzungu, 2004).

A number of households (62%) from the gazetted settlements pay for the water that they use for domestic purposes. Maun Village has the highest percentage of households (56%) paying for water. There is a statistical association between settlement and payment for water (Pearson's chi-square test value = 387.405[a], degrees of freedom = 7, p=0.000) at 5% significant level. Households across the different settlement categories pay an average of USD4 per month for the water that they consume. Households paying for water are those with private water connections while those who access water from public standpipes do not pay anything. Households pay nominal charges as opposed to the full economic cost of the water. Though households are supposed to pay for water, on an annual basis, NWDC used to collect 20% of what they were supposed to be collecting from households with private connections while DWA was owed almost USD300,000 by households from Maun Village at the time WUC took over water supply in Ngamiland in April 2013. WUC took over all these debts and started encouraging residents to pay what they owed.

7.2. Conclusions

In line with specific objectives of this thesis presented in Chapter One, the major conclusions are as follows:

i) There is acute household water insecurity for the majority of households in all the different settlement categories of Ngamiland. This is evidenced by more than 74% of households being affected by this phenomenon. Households in Ngamiland are not accessing enough safe water which enables them to lead clean, healthy and productive lives. Households are compelled to access untreated water which is not suitable for enhancing human security. As a result, the majority of households in Ngamiland are not adequately protected from serious risk and threats of water insecurity. Water insecurity being experienced by households poses an existential threat to households and their members. Human security is being compromised in Ngamiland as a result of water insecurity which is a pervasive threat inconsistent with long term human

fulfilment. This situation obtaining in Ngamiland goes against 6 of the Sustainable Development Goals which urges country to ensure availability and sustainable management of water and sanitation for all.

ii) A number of factors which include environmental, climatic, socio-economic, demographic, financial and managerial, interact to cause household water insecurity in different settlement categories of Ngamiland. Though it would have been vital to single out the most important or outstanding factor, it is very difficult to do this since all the factors highlighted in this thesis contribute significantly to water insecurity in different settlement categories. What is vital is that some of the factors such as demographic and socio-economic development are more prominent in a settlement like Maun Village than in tertiary and ungazetted villages.

iii) In the context of water insecurity, households from different settlement categories become active actors as they devise their own coping (short-term) and, to a lesser extent, adaptation (long term) strategies. These strategies require some financial investment which most of the households cannot afford. The most common coping strategy used by households when they are confronted with water insecurity is accessing untreated water, mainly from perennial rivers.

iv) Water insecurity has gender and social dimensions. Women are the ones who have the major responsibility of fetching water when households experience water insecurity. Different assets are used by men, women and children to fetch water during times of water insecurity. During periods of water scarcity, households usually use assets which are inefficient, that is, 20 L or 25 L containers which are mainly head-loaded by women to the households. These assets also have some negative health implications as they cause neck and the spinal cord pain. The majority of households do not have access to assets which are relatively efficient such as donkey-drawn carts or light motor vehicles which allow them to fetch more water during times of water scarcity.

v) The water governance approach being used by the Government of Botswana has accentuated the household water insecurity in different settlement categories of Ngamiland. Though the Government of Botswana has embraced IWRM, this has not been operationalized in policy, legislation and programmes. Water management in the country is still being guided by legislation that dates back to the 1960s and does not take into consideration current management approaches.

7.3. Policy recommendations

The following policy recommendations with regards to household water security are suggested:

i) Water policy has to focus on improved water supply for households in gazetted settlements by ensuring that the already installed improved water sources supply water to households on a sustainable basis in order to enhance water security. Given the fact that water is a basic good to which there is no substitute, there is need for policy changes in order for the state and other actors to provide water supply services to already existing ungazetted settlements. Policies which discourage the further mushrooming of ungazetted settlements need to be put in place.

ii) In order to address factors which adversely affect household water security, the Government of Botswana should develop a sound water resource management policy that takes into consideration the different settlement categories. Policies should put more emphasis on dealing with factors related to climatic and hydrological factors, demographic changes, urbanisation, management challenges and water supply infrastructure which mostly affect large villages like Maun Village and to a lesser extent, tertiary villages. There is need for the Government of Botswana to put into place policies which curb further mushrooming of ungazetted settlements as well as formalising the already existing ungazetted villages which constitute a significant percentage of settlements in Ngamiland and ensure that these also receive water supply.

iii) The state should adopt more effective planned intervention policies aimed at enhancing household water security in different settlement categories. This can be done through the formulation of policies and strategies (i.e. short, medium and long term) for water security underpinned by research. The implementation of different strategies, such as rainwater harvesting, storm water harvesting and wastewater recycling, need to be promoted. Moreover, water security which takes into consideration issues of access, quality, quantity, availability and affordability need to be adopted as an appropriate measure for access to water as opposed to the mere presence of improved sources.

iv) In order to enhance water governance and to promote water security, the Government of Botswana should come up with a water legislation and policy framework which reflects the current operating environment as well as current water governance

approaches. Such a framework should highlight water resource management approaches that enhance water security as well as human security in different settlement categories. A major step would be the development of a comprehensive water resource management policy, underpinned by IWRM principles that guarantee access to water to households in different settlement categories. Such a policy should address factors which include climatic and hydrological factors, water governance, extreme events such as drought and floods, financial constrains, demographic changes, water supply infrastructure and supply of water to all settlements.

7.4. Future research

Future research on water security has to focus on the following:

i) Developing a quantitative or qualitative measure or threshold of water security which takes into consideration issues of accessibility, quality, quantity, availability and affordability for adoption as an appropriate measure for access to water as opposed to the mere presence of improved sources.
ii) How the Government of Botswana can supply water on a sustainable basis to all settlement categories, including those settlements that are categorized as ungazetted given that most settlements in Ngamiland are scattered.
iii) How households can adopt effective adaptation strategies such as rainwater harvesting in the event of water insecurity.
iv) Health and economic impact of water insecurity on households in different settlement categories of Ngamiland.

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ANNEX 1: RESEARCH PERMIT

TELEPHONE: (267) 365 6600
TELEGRAMS: MMEWR
TELEX: (267) 2503 BD
FAX: (267) 390 9368

REPUBLIC OF BOTSWANA

MINISTRY OF MINERALS, ENERGY AND WATER RESOURCES, PRIVATE BAG 0018, GABORONE BOTSWANA

Ref: GSC 5 XIV (30)

27 February 2012

Mr Krasposy Kujinga
Okavango Research Institute
Private Bag 285
Maun

E-mail: krasposy@gmail.com

RE: APPLICATION FOR A RESEARCH PERMIT

Your application for a research permit refers.

By this letter you are given permission to conduct a research entitled **"HOUSEHOLD WATER SECURITY IN DIFFERENT SETTLEMENT CATEGORIES OF NGAMILAND, BOTSWANA."**

The permit is valid for a period not exceeding twelve (12) months effective from the **1st March 2012 to 28th February 2013**.

The permit is granted subject to the following conditions:

1. Copies of reports produced as a result of the research are directly deposited with the following institutions: Ministry of Minerals, Energy and Water Resources, Private Bag 0018, Gaborone, Botswana; Ministry of Education, Private Bag 005, Gaborone, Botswana; National Archives and Records Services, PO Box 239, Gaborone, Botswana; Department of National Library Services, Private Bag 0036, Gaborone, Botswana; Office of Research and Development, University of Botswana, Private Bag 0022, Gaborone, Botswana.

2. The permit does not give authority to enter premises, private establishments or protected areas. Permission for such entry should be negotiated with those concerned.

3. The study is conducted according to the particulars furnished in the approved application, taking into account the above conditions.

4. Failure to comply with the above stipulated conditions will result in the immediate cancellation of the permit.

Yours faithfully,

L. Ungwang
For/**Permanent Secretary**

cc: Permanent Secretary, Ministry of Education
Director, Botswana Archives and Records Services
Director, Botswana National Library Services
Director, Research and Development Office (University of Botswana)

ANNEX 2: HOUSEHOLD WATER SECURITY SURVEY QUESTIONNAIRE

Date of interview

Start time

Name of Enumerator: _____

BACKGROUNG INFORMATION							
A1		**A2**			**A3**		
Settlement category		**Name of settlement (*leina la motse)***			**Name of ward *(Leina la kgotla)***		
Primary Centre	1	Maun	1		Chobe	1	
Secondary centre	2	Matlapaneng	2	→ ***A4***	Boyei	2	
Tertiary centre	3	Somelo	3	→ ***A4***			
Ungazetted village	4	Ikoga	4	→ ***A4***			
		Gucha	5	→ ***A4***			
		Samedupi	6	→ ***A4***			
		Ukkusi	7	→ ***A4***			
		Xobe	8	→ ***A4***			
INFORMED CONSENT I the enumerator, hereby confirm that I understand the entirety of the informed consent issue and the respondent has agreed to participate in this study ..... Enumerator's signature					**RESULTS** Completed Not at home Postponed Refused Partly completed Incapacitated (The respondent might be too ill to respond) Other		1 2 3 4 5 6 7

A4		**A5**	
Sex of respondent *(Bong)*		**Age group of respondent *(Dingwaga tsa yo o bodiwang)***	
Male	1	15 – 19	1
Female	2	20 – 24	2
		25 – 29	3
		30 – 34	4
		35 – 39	5
		40 – 44	6
		45 – 49	7
		50 – 54	8
		55 – 59	9
		60+	10

HOUSEHOLD CHARACTERISTICS				
B1	Type of housing (**Mohuta wa ntlo**)	Multi-semi detached compound Semi detached house Detached house Homestead	1 2 3 4	
B2	Who is the head of this household? (**Tlhogo ya lelwapa ke mang?**)	Male Female	1 2	
B3	How old is the head of this household? (**Dingwaga tsa tlhogo ya lelwapa di kahe?**)	15 – 19 20 – 24 25 - 29 30 – 34 35 – 39 40 – 44 45 - 49 50 – 54 55 - 59 60+	1 2 3 4 5 6 7 8 9 10	
B4	How many people live on this property?(**lo nna le le kae mo lwapeng?)**		…….	
B5	How many of these are over 18years old? (**ke bale kae ba ba dingwaga di fitlang 18?**)	Males Female	....	
B6	How many are between 12 – 17years? (**Ke bale kae ba dingwaga tse 12-17?**)	Males Female	....	
B7	How many are 5 – 11 years old? **(ke ba lekae ba dingwaga tse di 5 – 11?)**	Males Female	....	
B8	How many are 0 – 4 years old? **(ke balekae ba dingwaga tse 0 – 4?)**		.....	
B9	How many people lived in this household in 2007? (**Mo lapeng la gago le ne nna le le kahe ka 2007 ?**)	Number of household member Household did not exist	....	
B10	What has been the trend in water use by your household since 2007? **(Seemo koketsego/phokotsego ya tiriso ya metsi se ne se ntse jang ka 2007?)**	Stable Decreased Increased Increased rapidly	1 2 3 4	
B11	What is the total household income per month? (**Madi a a tsenang mo lwapeng ka kgwedi ke bokae?)**	<P100 P101 – P500 P501 – P1000 P1001 – P5000 P5001 – 10 000 P10 000 – 20,000 >20,000	1 2 3 4 5 6 7	
B12	For how long have you been living in this settlement?(**Ona le lobaka lo lo kae o nna fa**?)	Number of years: Or Year Months	…….	
B13	Has your household ever relocated to another area within the last 30 years? (**A wena le ba lelwapa la gago le kile la hudugela gongwe mo ngwageng tse 30 tse di fitileng**?)	Yes No	1 2	→ ***B20***
B14	What was the main reason for relocating? (**Mabaka a go huduga ene ele eng**?)	Domestic water supply problems Floods Work related reason Climate related reason School for children reason Government relocation Other	1 2 3 4 5 6 7	
B15	How many times has your household relocated? (Wena le ba **lelwapa le, le hudugile ga kae**?)	Number of times	.....	
B16	Did you relocate within the last two years? (**A lo kile lwa huduga mo ngwageng tse pedi tse di fitileng**)	Yes No	1 2	

B17	Is your household considering relocating again? (**A lo akanya go huduga** gape?)	Yes No	1 2	 → ***B20***
B18	Why would you want to relocate from this area? (**ke eng se se lo gwetlhang go huduga?**)	Domestic water supply problems Floods Work related reason Climate related reason School for children reason Government relocation Other	1 2 3 4 5 6 7	

HOUSEHOLD ASSET OWNERSHIP							
	BB20	B20	B21	B23	B24	B25	B26
Which of the following assets does this household own or have free access to?	**Do you own any of the following?**	**Number owned**	**Year acquired**	**Free access (tick)**	**In use for the past five years** **1 = Yes** **2 = No**	**Used for ferrying household water?**	**Do you at times have to fetch water for these animals?**
Motor vehicle – Truck	**1 2**			**1 2**	**1 2**	**1 2**	
Motor vehicle – Sedan	**1 2**			**1 2**	**1 2**	**1 2**	
Bicycle	**1 2**			**1 2**	**1 2**	**1 2**	
Wheelbarrow	**1 2**			**1 2**	**1 2**	**1 2**	
Washing machine	**1 2**			**1 2**	**1 2**		
Dish washer	**1 2**			**1 2**	**1 2**		
Scotchcart/ water cart	**1 2**			**1 2**	**1 2**	**1 2**	
Cattle	**1 2**			**1 2**		**1 2**	**1 2**
Donkeys	**1 2**			**1 2**		**1 2**	**1 2**
Goat	**1 2**			**1 2**			**1 2**
Cattle	**1 2**			**1 2**			**1 2**
Horses	**1 2**			**1 2**			**1 2**
Sheep	**1 2**			**1 2**			**1 2**

NB: Column B3 is filled if the asset is not owned or was not acquired by the household. The household will be using maybe a neighbour, relative or friend's asset.

ESTABLISHING WATER SECURITY PROBLEMS				
C1	What are the major domestic water uses by your household? (***Ke dife tsa mo lwapeng tse lo dirisang metsi thata mo go tsone?)***			
			Y N	
		Cooking	1 2	
		Drinking	1 2	
		Toilet flushing	1 2	
		Bathing	1 2	
		General cleaning	1 2	
		Hand washing	1 2	
		Small gardening	1 2	
		Orchard	1 2	
		Small livestock	1 2	
		Swimming pool	1 2	
		Other:		
C2	What is the approximate distance to the household's main water source? *(**Fa lo gang metsi teng go bokgakala bokae go tswa mo lwapeng?**)*			
			<50m	1
			51 – 100m	2
			101 - 200m	3
			201 – 500m	2
			501 – 1km	5
			1km – 2km	6
			2,1km – 5km	7
			>5km	8
C3	What is the household's main source of water? ***(Lo gelela metsi a lo a dirisang kae?)***			
			Piped water inside house	1
			Piped water into yard/plot	2 → ***C11***
			Communal tape	3 → ***C19***
			Perennial River	4 → ***C24***
			Stream	5 → ***C28***
			Unprotected dug well	6 → ***C32***
			Borehole	7 → **C36**
			Neigbour/s ' home	8 → **C40**
			Other (Specify)	9

C3.1	Approximately, how much water does each member of the household use per day? **Mongwe le mongwe yo o nnang mo lapeng le o tlhoka selekanyo se se kafe sa metsi ka letsatsi?**			
C4	Who is your service provider for piped water supply inside house? **(Baanamisi ba ba le tlisetsang metsi mo ntlong ke ba bafe?**	District Council Department of Water Affairs Water Utilities Corporation Own provider Don't know Other	1 2 3 4 5 6	
C5	When was piped water system inside house installed in your house? ***(Le tsenyeditswe metsi mo ntlung leng?)***	Year Don't remember	1.... 2....	
C6	How much did you invest for a piped water system inside house? **(*O duetse bo kahe go tsenyediwa metsi mo ntlung?)***			
C7	What was your main water source before the installation of piped water inside house*?* ***(Pele ga le tsenyediwa metsi mo ntlung o ne o gelela metsi kae?)***	Piped water into yard/plot Communal tape Perennial River Stream Unprotected dug well Other (Specify	1 2 3 4 5 6	
C8	Did your household's water use increase since the installation of piped water system inside house? ***(A tiriso ya lona ya metsi e ne ya oketsega fa le sena go tsenyediwa metsi mo ntlung?***	Yes No	1 2	**→C10**
C9	Your household water use increased approximately by what percentange? ***(O kare tiriso ya lona ya metsi e oketsegile ka bo kahe mo lekgolong?)***			
C10	In the event of a normal water supply, approximately how much water does your household use per month from your piped water supply inside house? (***lo dirisa selekanyo sa metsi se sekae mo lwapeng ka kgwedi?****)* Check from previous water bills **(*dirisa diresiti tse di fitileng)***		L	***→C22***
C11	Who is your service provider for piped water supply outside tap on yard? ***(Baanamisi ba ba le tlisetsang metsi mo lapeng ke bafe?)***	District Council Department of Water Affairs Water Utilities Corporation Own provider Don't know Other	1 2 3 4 5 6	
C12	When was piped water system into yard/plot installed? ***(Le tsenyeditswe metsi mo lapeng leng?)***	Year Don't remember	1.... 2	
C13	How much did you invest for a piped water system outside tap on yard? ***(O duetse bo kahe go tsenyediwa metsi mo lapeng?)***	P		
C14	What was your main water source before the installation of piped outside tap on yard? ***(Pele ga le tsenyediwa metsi mo lapeng o ne o gelela metsi kae?)***			
C15	Did your household's water use increased since the installation of piped water system outside tap on yard*?* ***(A tiriso ya lona ya metsi e ne ya oketsega fa le sena go tsenyediwa metsi mo lapeng?)***	Yes No	1 2	**→17**

C16	Your household water use increased approximately by what percentage? ***(O kare tiriso ya lona ya metsi e oketsegile ka bo kahe mo lekgolong?)***			
C17	In the event of a normal water supply, approximately how much water does your household use per month from your piped in yard/plot? ***lo dirisa selekanyo sa metsi se sekae mo lwapeng ka kgwedi ?)*** *Check from previous water bills* ***(dirisa diresiti tse di fitileng)***		L	**→*C22***
C18	Who is your service provider for piped water supply through communal tap? ***(Baanamisi ba ba le tlisetsang metsi mo pompong ya setshaba ke bafe?***	District Council Department of Water Affairs Water Utilities Corporation Own provider Don't know Other	1 2 3 4 5 6	
C19	For how long has your household been obtaining water from a communal tap*? **(Le na le nako e e kahe le gelela metsi mo pompon ya setshaba**?)*			
C20	What can you say about the amount of water your household get from the communal tap since 2007? ***(O kare seemo sa koketsego/phokotsego ya tiriso ya metsi ke se se ntseng jang go tswa ka 2007 go fitlha gompieno?)***	Decreasing Stable Increasing	1 2 3	
C21	In the event of a normal water supply, how long does it take members of your household to fetch water from the communal tap? (***mo nakong ya metsi a le teng, go tsaya wena kana ba lapa la gago nako e e kahe go ya go gelela metsi?***	Hrs Min	....	
C21.1	Access to water at the communal tap is? ***(Mohuta wa tiriso ya go gelela metsi ke o o ntseng jang?)***	By pre-paid card Free	1 2	**→C22**
C21.2	How much water can you access a day using an pre-paid card? ***(Le ka gelela gelela metsi a selekanyo se sehe ha le dirisa karata?)***		L	
C21.3	For how long have you been using pre-paid cards? ***(Ke labaka le le kahe le dirisa karata?)***			
C21.4	Is this a good system? ***(A o kare ke tsamaiso e e siameng?)***	Yes No	1 2	
C21.5	Explain your answer **qC21.3** ***(Tlhalosa karabo ya gago go postso qC21.3?)***			
C22	How do you rate the quality of service by your service provider? (**Seemo sa ditirelo tsa metsi ke se sentseng jang go tswa ko go ba ba lo thusang**?)	Very good Good Average Poor Very Poor	1 2 3 4 5	
C23	Explain your answer in **qC22**? ***(Tlhalosa karabo ya gago go potso qC22?)***			**→C44**

C24	For how long has been your household fetching water from the river? ***(Ke lebaka le le kahe le gelela metsi go tswa mo nokeng?)***	Years Months	....	
C25	How do you rate accessibility of water for household use from the perennial river? ***(seemo sa boleng ja***	Very good Good	1 2	

	metsi a a tsewang ko nokeng e nnang e ela ke se se ntseng jang?)	Average Poor Very poor	3 4 5	
C26	Explain your answer in ***qC11 (Tlhalosa karabo ya gago go potso qC11?)***			
C27	How has been the flow of the perennial river within the last 5 years? ***(Seemo sa go tshela ga metsi e ntse e le se ntseng jang mo dingwageng tse tlhano tse di fitileng?)***	Flow has been stable Flow has been fluctuating Frequent drying Frequent flooding Other	1 2 3 4 5	
C28	For how long has your household been fetching water from the stream? ***(Ke lebaka le le kahe le gelela metsi go tswa mo nokeng?)***	Years Months	....	
C29	How do you rate accessibility of water for household use from the stream? *(**O bona seemo sa go nna teng ga metsi, a a dirisiwang mo lwapeng, a tsewa mo molatswaneng ele se se ntseng jang**?)*	Very good Good Average Poor Very poor	1 2 3 4 5	
C30	Explain your answer in **qC29 (Tlhalosa karabo ya gago go potso qC29?)**			
C31	What has been state of flow of the stream over the last 5 years? (***Seemo sa go tshela ga metsi mo molatswaneng se ne se ntse jang mo dingwageng tse tlhano tse di fitileng?)***	Flow has been stable Flow has been fluctuating Frequent drying Frequent flooding Other	1 2 3 4 5	
C32	For how long has your household been fetching water from the unprotected well? ***(Ke lebaka le le kahe le gelela metsi go tswa mo petseng/kakweteng?)***	Year Months	....	
C33	How do you rate accessibility of water for household use from the unprotected well? *(**Okare go bonala ga metsi mo petseng/kakwete se se sa sirelediwang ke mo go ntseng jang**?)*	Very good Good Average Poor Very poor	1 2 3 4 5	
C34	Explain your answer in **qC33** ***(Tlhalosa karabo ya gago go potso qC33?)***			
C35	What has been the state of the unprotected well over the last 5 years? ***(Seemo sa gonna teng ga metsi mo Sedibeng/petseng se ntse e le se sentseng jang mo ngwageng tse tlhano tse di fitileng?)***	Always having water Dries up in dry season Has bad quality water Other	1 2 3 4	
C36	For how long has your household been accessing water from a borehole*? **(Ke lebaka le le kahe le gelela metsi go tswa mo sedibeng?)***			
C37	What is the ownership status of this borehole? ***(Ke mang mong was sedisa se?)***	Owned by the household Owned by the Water Affairs Owned by the District Council Owned by the community	1 2 3 4	
C38	How do you rate accessibility of water for household use from the borehole? *(**Okare go bonala ga metsi mo sedibeng ke mo go ntseng jang**?)*	Very good Good Average Poor Very poor	1 2 3 4 5	
C39	Explain your answer in **qC38** ***(Tlhalosa karabo ya gago go potso qC38?)***			
C40	For how long has your household been accessing water from neighbour's place? **(Ke lebaka le le kae ntse le gelela metsi ko baagisanye?)**			
C41	Explain why you are accessing water from your neigbour's place in **qC40**			

	(Ke ka goreng o gelela metsi ko baagisanye?)			
C42	How do you rate accessibility of water for household use from the borehole? **(O ka tshwaela jang ka tsela e o bonang metsi ka yone go tswa ko sedibemg?)**	Very good Good Average Poor Very poor	1 2 3 4 5	
C43	How much water can your household access from your neighbours places on each day? **(O gelela metsi a selekanyo se se kae go tswa ko baagisanyeng ka letsatsi?)**			
C44	Within the last 1 - 5 years, has your household been having water readily available from your main source? ***(Mo ngwageng tse tlhano tse di fitileng a lo kile lwa tlhoka metsi ko lo gelelang teng**?)*	Yes No	1 2	
C45	Within the last 12 months, has your household been having water readily available from your main source? *(**Mo kgweding tse 12 tse di fitileng a lo kile la tlhoka metsi mo lwapeng go tswa ko lo a agang teng?)***	Yes No	1 2	**→F*1***
C46	When was the last time you experienced a water problem within the last 12 months? ***(Ke leng la bofelo lo tlhoka metsi mo lo a gelelang teng?)***	No water now Within the last 24 hours Within the last one week Within the last two weeks Within the last month More than a month More than 3 months ago Six months ago 12 months ago	0 1 2 3 4 5 6 7 8	
C46.1	Fow how long do water disruptions usually last			
FACTORS AFFECTING WATER SECURITY				
D1	Do you think increase in population in this settlement within the last 10 years is behind the current water problems***? (a o kare go koketsego ya batho mo motseng oo mo ngwageng tse 10 tse di fitileng ke yone e dirileng gore gonne le bothata jwa metsi?)***	Yes No	1 2	→ ***D4***
D2	What factors do you think have been behind population growth in this settlement in the last ten years*?(**Ke dife tse o boneng di dira koketsego ya batho mo motsing o?)***	Natural growth In migration from other areas Other	1 2 3	
D3	How do you think population has increased in this area within the last 10 years ***(O kare palo ya batho e oketsegile jang mo ngwageng tse 10 tse di fitileng)***	Slightly increase Doubled Trebled Other	1 2 3 4	
D4	Do you think there has been an increase in water use by residents in this settlement? *(**A o akanya gore baagi ba okeditse tiriso ya metsi mo motseng**?)*	Yes No Not sure	1 2 3	→ ***D6*** → **D6**
D5	What do you think is causing increased water use by residents in this settlement? *(**Ke eng se o kareng se dirile koketsego ya tiriso ya metsi mo motseng**?)*	Increased private connections Changing lifestyles Not sure Other	1 2 3 4	
D6	Do you think there are water management challenges on the part of your service provider causing water problems *(**A o kare gona le mathata a ba ba anamisang metsi ba kopanang le one a a ba kgoreletsang mo**	Yes No	1 2	→ ***D8***

	tirong ya bone?)			
D7	What do you think can explain management challenges by service provider? ***(Go ya ka wena o kare mathata a a lebaganang ba ba ntshang dithuso tsa metsi ke afe?)***	Limited funding from government Old water infrastructure Poor water distribution Other	1 2 3 4	
D8	Do you think droughts in this area are behind the current water problems? *(**A o kare leuba ke lone le bakang bothata jwa metsi mo kgaolong eno**?)*	Yes No	1 2	→ ***D11***
D9	How frequent are droughts in this area? *(**leuba lenna gakae mo kgaolong ee**?)*	Very frequent – yearly Frequent – after 2-3 years Not very frequent – once in five years Other	1 2 3 4	
D10	How have droughts affected household water supply? *(**Leuba le amile jang metsi a lo a dirisang mo lwapeng**?)*	Drying of surface water resources Falling of groundwater resources Increased water demand Other	1 2 3 4	
D11	Do you think there has been a decrease in rainfall which have affected water supply? ***(A o kare gore go nnile le phokotsego ya pula e amile go bonala ga metsi a a dirisiwang mo lwapeng?)***	Yes No	1 2	→ ***D14***
D12	To what extent do you think rainfall has fallen over this area within the last 10 years? ***(O kare Seemo sa gona ga pula e ne e le se se ntseng jang mo ngwageng tse 10 tse di fitileng go tla go tsena mo gompieno?)***	Slightly reduced Greatly reduced Other	1 2 3	
D13	What have been the impacts of reduced rainfall on household water supply? ***(Go hokotsega ga gona ga pula go amile jang seemo sa metsi mo lwapeng?)***	Reduced surface water resources Fall in level of groundwater resources Other	1 2 3	
D14	Does this area experience flooding which could affect water supply. ***(a go tshela ga metsi kakwano go kgoreletsa go bonala ga metsi a a dirisiwang mo lwapeng?)***	Yes No	1 2	→ ***D17***
D15	How often does flooding take place in this area? (***Go tshela ga metsi a mantsi go nna gakae mo kgaolong e?)***	Annually Once in 5 years More than once in 5 years Not sure Other	1 2 3 4 5	
D16	How has frequent flooding affected the supply of household water supply? ***(go tshela ga metsi a mantsi kgapetsa kgapetsa go amile seemo sa metsi jang mo lwapeng?)***	Increased pollution of water sources Submerging of boreholes Other	1 2 3	
D17	Do you think technical factors are behind the current water shortages ***(A o kare go na le mathata a tsa boranyane a a bakang tlhaelo ya metsi?)***	Yes No	1 2	→ ***D19***
D18	How has technical factors affected household water supply? *(**Mathata tsa boranyane a amile jang seemo sa metsi mo lwapeng**?)*	Poor management practices Poorly skilled manpower Constant breakdown of pumps Other	1 2 3 4	
D19	Do you think poor water quality is behind water problems being experienced? ***(A o kare boleng jo bo ko tlase jwa seemo sa metsi bo baka mathata a go bonala ga metsi?)***	Yes No	1 2	→ ***D21***
D20	What do you think are the major causes of poor	Pollution because of flooding	1	

	water quality? ***(Tsa konokono tse di bakang boleng jo bo ko tlase jwa metsi ke dife?)***	Human induced pollution Poor water treatment process Poor quality of groundwater Other	2 3 4 5	
D21	Could you please tell me any other factors which you think are behind water problems? ***(A o ka tlhalosa dingwe gape tse o dumelang gore dibaka bothata jwa boleng jo bo kwa tlase jwa metsi)***			
COPING AND ADAPTION STRATEGIES &SOCIAL AND GENDER RELATIONS ***(Go Itepatepanya le mathata, Dikgang Tsa Bong le Selegae)***				
E1 to E9 ask only those whose main water source is piped water system in house, yard or communal tap. ******For households whose main water source is the river, stream or unprotected well, go to E9***				
E1	Does your household ever get water from a river when you are experiencing problems? (**A lo atle loge metsi ko nokeng ha gona le bothata jwa go bonala ga metsi mo dithepeng**)	Yes No	1 2	→***E3***
E2	What is the distance to the river? (**Noka e bokgakala bokae? Seelo ka dimitara**	<200m 200 – 500m 500 – 1km 1km – 2km 2km – 5km >5km	1 2 3 4 5 6	
E3	Does your household ever get water from a stream when you are experiencing problems? ***(A lo atle lo gelela metsi ko nokeng ha gona le bothata jwa go bonala ga metsi mo lwapeng?)***	Yes No	1 2	→***E5***
E4	What is the distance to the stream? ***(Noka e bokgakala bokae?Seelo ka dimitara?)***	<200m 200 – 500m 500 – 1km 1km – 2km 2km – 5km >5km	1 2 3 4 5 6	
E5	Does your household ever get water from an unprotected well when you are experiencing problems? ***(A lo kile la ga metsi ko petseng/sediba se se sa sirelediwang ha gona le bothata jwa go bonala ga metsi mo lwapeng?)***	Yes No	1 2	→***E7***
E6	What is the distance to the unprotected well? ***(Petse/sediba se bokgakala bokae? Seelo ka dimitara?)***	200m 200 – 500m 500 – 1km 1km – 2km 2km – 5km >5km	1 2 3 4 5 6	
E7	Does your household ever get water from a communal tap when you are experiencing problems? ***(A lo tle lo ge metsi ko dipompong tsa morafe ga lona le bothata jwa metsi mo lwapeng?)***	Yes No	1 2	→***E9 or F1 if no to all of the above***
E8	What is the distance to the communal tap? ***(Pompo ya morafe e bokgakala bokae?Seelo ka dimitara?)***	200m 200 – 500m 500 – 1km 1km – 2km 2km – 5km >5km	1 2 3 4 5 6	
For residents whose main source has always been the river, stream or unprotected well. Also for respondents who indicate that they are fetching water from the river, stream, (un)protected well and communal tap as a result of water problems.				

E9	Which age groups are responsible for fetching water for household use within your household during periods of water problems? ***(mo lwapeng le, ke ba dingwaga di he ba ba itebagantseng le go gelela metsi?)***	Female members >18yrs 1 ***(ask E10)*** 2 Male members >18yrs 1 ***(ask 11)*** 2 Female members ,12 – 17 yrs 1 (***ask E12***) 2 Male members,12 – 17yrs 1 ***(ask E13)*** 2 Children, 5 - 11 yrs 1 ***(ask E14***) 2		
E10	Why do you have female members >18yrs fetching water? ***(Ke ka goreng bomme ba dingwaga tse di fetang 18 ele bone ba gang metsi?)***	To ensure that household has adequate water They are the ones who use most of the water To get water for their own personal use Other	1 2 3 4	
E11	Why do you have male members >18yrs fetching water? ***(ke ka goreng borre ba dingwaga tse di fetang 18*** **ele bone ba gang metsi?)**	To ensure that household has adequate water They are the ones who use most of the water To get water for their own personal use Other	1 2 3 4	
E12	Why do you have female members who are 12yrs – 17yrs fetching water? ***(ke eng fa basetsana ba dingwaga tse 12-17 ele bone ba gang metsi?)***	To ensure that household has adequate water They are the ones who use most of the water To get water for their own personal use Other	1 2 3 4	
E13	Why do you have male members who are 12yrs – 17yrs fetching water? ***(Ke ka goreng basimane ba dingwaga tse di 12yrs- 13yrs ele bone ba gang Metsi)***	To ensure that household has adequate water They are the ones who use most of the water To get water for their own personal use Other	1 2 3 4	
E14	Why do you have children who are 5 - 11 yrs below fetching water? ***(ke ka goreng bana ba dingwga tse di 5 – 11 ele bone ba gang metsi?)***	To ensure that household has adequate water They are the ones who use most of the water To get water for their own personal use Other	1 2 3 4	
E15	Do different age groups of people who fetch water within your household, use different types of containers? *?(* ***A batho ba dingwaga tse di farologanyeng ba dirisa di didirisiwa tse di farologanyeng go gelela metsi)***	Yes No	1 2	***→E21***
E16	What type of containers are normally used by female members >18yrs? ***(ke mofuta ofe wa didirisiwa tse di beelang/gellang metsi tse di dirisiwang ke bomme ba dingwaga tse di fetang 18?)***	200L 100L 50L 25L 20L 10L 5L 2L Other	1 2 3 4 5 6 7 8 9	
E17	What type of containers are normally used by male members >18yrs? ***(ke mofuta ofe wa didirisiwa tse di beelang/gellang metsi tse di dirisiwang ke borre ba dingwaga tse di fetang 18?)***	200L 100L 50L 25L 20L 10L 5L 2L Other	1 2 3 4 5 6 7 8 9	
E18	What type of containers are normally used by female members who are 12 - 17yrs? ***(ke mofuta ofe wa didirisiwa tse di beelang/gellang metsi tse di dirisiwang ke bomme ba dingwaga tse 12 - 17?)***	200L 100L 50L 25L 20L 10L 5L 2L Other	1 2 3 4 5 6 7 8 9	

E19	What type of containers are normally used by male members who are 12 – 17? ***(ke mofuta ofe wa didirisiwa tse di beelang/gellang metsi tse di dirisiwang ke bo rre ba dingwaga tse 12-17?)***	200L 100L 50L 25L 20L 10L 5L 2L Other	1 2 3 4 5 6 7 8 9	
E20	What types of containers are normally used by children who are 5 – 11? ***(ke mofuta ofe wa didirisiwa tse di beelang/gellang metsi tse di dirisiwang ke ba dingwaga tse di 5 – 11)***	200L 100L 50L 25L 20L 10L 5L 2L Other	1 2 3 4 5 6 7 8 9	
E21	Which containers do all members within your household use*? **(ke mofuta ofe wa didirisiwa tse di beelang/gellang metsi tse di dirisiwang ke batho botlhe)***	200L 100L 50L 25L 20L 10L 5L 2L Other	1 2 3 4 5 6 7 8 9	
E22	Do different age groups of members within your household go to fetch water different number of times per day? ***(Mo lapeng le, a batho ba dingwaga tse di farologaneng ba gelela metsi ka makgetho farologaneng mo letsatsing?)***	Yes No	1 2	→***E28***
E23	How many times a day do female members who are >18yrs go to fetch water? *(**Bomme ba dingwaga tse di fetang 18 ba gelela metsi ga kahe mo letsatsing**?)*	>5 times 5 times 4 times 3 times 2 times Once When need for water arises	1 2 3 4 5 6 7	
E24	How many times a day do male members who are >18yrs go to fetch water? ***(Borre ba dingwaga tse di fetang 18 ba gelela metsi ga kahe mo letsatsing)***	>5 times 5 times 4 times 3 times 2 times Once When need for water arises	1 2 3 4 5 6 7	
E25	How many times a day do female members who are 12 – 17yrs go to fetch water? ***(Basetsana ba dingwaga tse di 12 - 17 ba gelela metsi ga kahe mo letsatsing?)***	>5 times 5 times 4 times 3 times 2 times Once When need for water arises	1 2 3 4 5 6 7	
E26	How many times a day do male members who are 12 – 17yrs go to fetch water*? **(Basimane ba dingwaga tse 12 - 17 ba gelela metsi ga kahe mo letsatsing?)***	>5 times 5 times 4 times 3 times 2 times Once	1 2 3 4 5 6	

		When need for water arises	7	
E27	How many times a day do children who are 5 - 11yrs go to fetch water? ***(Bana ba dingwaga tse di 5 - 11 ba gelela metsi ga kahe mo letsatsing)***	>5 times 5 times 4 times 3 times 2 times Once When need for water arises	1 2 3 4 5 6 7	
E28	How many times per day do all household members go to fetch water*? (**Ba lelwapa ba gelela metsi ga kahe mo letsatsing?)***	>5 times 5 times 4 times 3 times 2 times Once When need for water arises	1 2 3 4 5 6 7	
E29	How long does it take per trip the following members of your household to fetch water? *(**go tsaya ba lwapa lebaka le le kae go ya le go boa ko le gelelang metsi teng**?)*	Female members >18yrs …….hrs…. min Male members >18yrs …….hrs…. min Female members ,12 – 17 yrs …….hrs… min Male members, 12 – 17yrs …….hrs… .min Children, 5 - 11 yrs. ……. hrs……min		
E30	Do different members of the household use different means to transport water to the homestead? ***(a ba lelwapa ba dirisa digogi/ditsamaisi tse di farologanyneng go tlisa metsi mo lapeng?)***	Yes No	1 2	→***E36***
E31	How do female members who are >18yrs transport water to the homestead*? (**Bomme be dingwaga tse hetang 18 ba dirisang eng go tlisa metsi mo lapeng**?)*	Head Hands Donkey drawn cart Vehicle Wheelbarrow Bicycle Dug out canoe Other	1 2 3 4 5 6 7 8	
E32	How do male members who are >18yrs transport water to the homestead? ***(Borre be dingwaga tse hetang 18 ba dirisang eng go tlisa metsi mo lapeng?)***	Head Hands Donkey drawn cart Vehicle Wheelbarrow Bicycle Dug out canoe Other	1 2 3 4 5 6 7 8	
E33	How do female members who are 12 - 17yrs transport water to the homestead? ***(Basetsana ba dingwaga tse di 12 - 17 ba dirisa eng go tlisa metsi mo lapeng?)***	Head Hands Donkey drawn cart Vehicle Wheelbarrow Bicycle Dug out canoe Other	1 2 3 4 5 6 7 8	
E34	How do male members who are 12 - 17yrs transport water to the homestead? ***(Basimane ba dingwaga tse 12 - 17 ba dirisa eng go tlisa metsi mo lapeng?)***	Head Hands Donkey drawn cart Vehicle Wheelbarrow Bicycle Dug out canoe Other	1 2 3 4 5 6 7 8	
E35	How do children who are 5 - 12yrs transport water to the homestead? ***(Bana ba dingwaga tse 5 – 12 ba***	Head Hands	1 2	

	dirisa eng go tlisa metsi mo lapeng?)	Donkey drawn cart Vehicle Wheelbarrow Bicycle Dug out canoe Other	3 4 5 6 7 8	
E36	How do all members of the household transport water to the homestead? ***(Ba lelwapa botlhe ba dirisa eng go tlisa metsi mo lapeng**?)*	Head Hands Donkey drawn cart Vehicle Wheelbarrow Bicycle Dug out canoe Other	1 2 3 4 5 6 7 8	
E37	Are there members of the household who do not want to fetch water? **(A gona le bangwe ba lelwapa ba sa rateng go ya go gelela metsi?)**	Yes No	1 2	→***E40***
E38	Which members do not want to go and fetch water*?* ***(ke ba bafe ba ba sa rateng go ya go gelela metsi?)***	Female members, >18yrs Male members, > 18 years Female members 12 – 17yrs Male members, 12 – 17 yrs Children, 5 – 11 yrs	1 2 3 4 5	
E39	Why is it that these members of the household do not want to fetch water? ***(Ke ka goreng bangwe ba lelwapa ba sa rate go ya go gelela metsi)***	They want others to fetch water for them They think it's not their duty to do so Other	1 2 3	
E40	Do you have family members who are unable to go and fetch water? **(*A gona le bangwe mo lwapeng ba ba senang bokgoni jwa go ya go gelela metsi?)***	Yes No	1 2	→***F1***
E41	What is the problem with these members? ***(bothata ke eng ba sakgonego ya go gelela metsi?)***	They are too old to fetch water They are disabled They are too young They are sick Other	1 2 3 4 5	
E42	How many of these members do you have? ***(Lona le ba lekae mo lwapeng ba ba sa kgoneng ya go gelela metsi?)***	Too Old Disabled Too young. Sick Other	… … …. ….	

COPING AND ADAPTATION STRATEGIES

F1	Do you practice rainwater harvesting? ***(A lo tle lo beeletse metsi a pula?)***	Yes No	1 2	→ ***F11***
F2	When did you start rainwater harvesting? ***(Lo simolotse leng go beeletsa metsi a pula)***	Year		
F3	What method do you use to harvest rainwater? **(Lo dirisa mohuta ofe go beeletsa metsi a pula?)**	Roof top using water gutters into storage tank Roof top using open containers Rooftop using closed containers	1 2 3	→***F8*** →***F8.1***
F4	What size of storage tank do you use to harvest water? ***(Lo dirisa sebeelo se se kahe sa metsi go beeletsa metsi)***	200L 500L 1000L 2500L 5000L 10,000L	1 2 3 4 5 6	
F5	How much did you invest in the water harvesting system that you have? ***(lo dirisitse bokae go reka/gonna le tse lo di dirisang go beeletsa metsi a pula)***	P…….. Nothing	1 2	
F6	How much water can you harvest in a month during the rainy season? ***(lo kgona go bona selekanyo sa***		L	

	metsi pula se sekae mo pakeng ya pula?)			

F7	If your storage tank fills up, how long does it take your household to finish the water? **(*Fa sebeelo sa metsi se tletse se ka lo tsaya nako e e kae gore metsi a teng a bo a fedile?)***	Day Weeks Months	…… …… ……	
F8	What size of open containers do you use to collect rainwater? ***(Lo dirisa selekanyo se sekae sa sebeeletso sa metsi?)***	10L 20L 50L 100L Other	....	
F8.00	What size of closed containers do you use to collect rainwater	10L 20L 50L 100L Other	....	
F9	How much can you collect with open/closed containers? ***(lo kgona go beeletsa metsi a selekanyo se se kae ka tse lonang natso tse dibeelang metsi?)***		L	
F10	Does the collection rainwater help you to reduce the number of trips you make to other sources? ***(A go beeletsa metsi a pula go le thusa go fokotsa makgetho/mesepele ya go ga metsi?)***	Yes No	1 2	
F11	Why is your household not involved in rainwater harvesting? ***(Ke ka goreng ba lelwapa la gago ba sa beeletse metsi a pula?)***	Not interested Cannot afford to install the system Do not know how to install the system No appropriate containers for water harvesting Other	1 2 3 4 5	
G1	Do you ever get water supplied to your settlement by a tanker/bowser? ***(A lo tle lo tsisediwe metsi mo motsing o ka dikoloi tse ditona tse di tshelang metsi?)***	Yes No	1 2	→***H1***
G2	Who mainly supplies you with water from a tanker/bowswe? ***(lo thusiwa ke bahe ka metsi a dikoloi?)***	District Council Department of Water Affairs Water Utilities Corporation Not sure Other	1 2 3 4 5	
G3	For how long has the tanker been supplying your? settlement with water? ***(Lo na le lebaka le le kae ntse lo thusiwa ka metsi a dikoloi?)***	Yeas Weeks Months	....	
G4	How often does the tanker supply you with water? ***(lo thusiwa ka metsi a dikoloi ga kae?)***	Daily After two days Weekly Fortnightly Haphazardly	1 2 3 4 5	
G5	How do the residents access water from the water tanker/bowser? ***(lo tsaya metsi go tswa mo dikoloi ka tsela/mokgwa oo ntseng jang?)***	Direct from storage tank Direct from the tanker/bowser From tanker/bowser into a pipe system Other	1 2 3 4	→***G6*** →***G7*** →***G8***
G7	Who within your household collect water from the tanker/bowser? ***(Mo lapeng ke mang yo gelelang metsi go tswa kwa koloing e e tlisa metsi?)***	Female members >18yrs 1 2 Male members >18yrs 1 2 Female members ,12 – 17 yrs 1 2 Male members,12 – 17yrs 1 2 Children, 5 - 11 yrs 1 2		
G8	Does the water tanker/bowser supply adequate water for all the households in this settlement? ***(A dikoloi di tlisa metsi a a lekanang batho botlhe mo motsing?)***	Yes No Not sure	1 2 3	

G9	Is your household able to collect adequate water supplied by the water tanker/bowser? ***(a lo kgona go gelela metsi a a lekaneng go dirisiwa mo lwapeng go tswa mo go tsone dikoloi tsa teng?)***	Yes No	1 2	
G10	Is the amount of water from the tanker/bowser adequate? ***(a metsi a dikoli a lekana ditiro?)***	No Yes	1 2	***→G12***
G11	How much would be enough for your household? ***(ke selekanyo se sekae se se ka dirisiwang mo lwapeng?)***		L	
G12	Are there days when the water tanker is not able to come to supply this community with water? ***(a gona le malatsi a koloi e sa kgoneng go tlisa metsi mo motseng?)***	Yes No Don't know	1 2 3	***→G15*** ***→H1***
G13	What would have happen in that case? ***(Go tlhoka go tlisa metsi mo go a bo go bakilwe ke eng?)***	Break down Fuel problems logistics problems Not sure Other	1 2 3 4 5	
G14	What is usually the longest period when the tanker is unable to come to supply water? ***(ke lobaka lolo kae koloi esa tlase metsi?)***	<24 hours One day 2-5days One week More than a week Other	1 2 3 4 5 6	
G15	Where do you get water when the water tanker fails to come to your settlement? ***(lo gelela metsi kae fa koloi e sa tsisa metsi mo motseng?)***	Store enough water for many days 1 2 Prioritize water use 1 2 Borrow from neighbours 1 2 Collect from nearest water source 1 2 Wait for the tanker to come 1 2 Other		
H1	Does your household ever use a vehicle to transport water? ***(a le dirisa koloi ya mo lwapeng go gelela metsi?)***	Yes No	1 2	***→i1***
H2	What type of a vehicle do you use? ***(le dirisa koloi ya mofuta ofe?)***	Sedan Truck Lorry Other	1 2 3 4	
H3	What is the ownership status of this vehicle? ***(ke koloi ya ga mang ?)***	Owned by household member/s Company vehicle Neighbour/Friend Hired Other	1 2 3 4 5	***→H5*** ***→H6***
H4	Which household member/s drive this vehicle? ***(Ke mang mo lwapeng yo kgweetsang koloi eo?)***	Male member/s Female member/s Both male and female member/s Other	1 2 3 4	
H5	Do you pay anything for this transportation? ***(a le duelela tiriso ya koloi e?)***	Yes No	1 2	***→H7***
H6	How much do you pay? ***(le duela bokae?***		P	
H7	For how long has your household been using a vehicle to transport water? ***(ke sebaka se sekae le dirisa koloi eo go tlisa metsi mo lwapeng?)***	Years Months Weeks	....	
H8	How often do you transport water?	Daily Weekly Fortnightly	1 2 3	

	(lo gelelela metsi makgetho a le kae?)	Monthly Whenever there is a water problem Other	4 5 6	
H9	Where do you transport the water from? ***(le gelela metsi kae?)***	Work Another settlement Town Church Other	1 2 3 4 5	
H10	Which of the following containers do you transport using a vehicle? ***(lo dirisa didirisiwa tsa selekanyo sefe fa lo dirisa koloi?)***	5L 1 2 10L 1 2 20L 1 2 50L 1 2 100L 1 2 200 1 2 500L 1 2 1,000L 1 2 2,500L 1 2 5,000L 1 2 10,000L 1 2		
H11	How many of the following containers do you transport per trip? ***(Mo go tse latelang, ke didirisiwa di le kahe tse le gelelang metsi ka tsone?)***	5L 10L 20L 50L 100L 200L 500L 1,000L 2,500L 5,000L 10,000L Other	....	
i1	Do you ever buy bottled water for household use? ***(a le reka metsi a mabotlele go a dirisa mo lwapeng?)***	Yes No	1 2	→ **J1**
i2	For how long have you been buying bottled water for your household? ***(Ke lebaka le le kahe le ntse reka metsi a mabotlele?)***			
i3	Why do you buy bottled water? ***(ke eng le reka metsi a mabotlele?)***	It is safer to drinker Cheaper Readily available Other	1 2 3 4	
i4	How often do you buy bottled water for household purposes? **(*le reka metsi a mabotlele a nowang, ga kae?)***	Everyday Weekly Fortnightly Monthly	1 2 3 4	
i5	How many litres do you buy per month? ***(le reka dilithara di le kae ka kgwedi?***		L	
i6	How much do you spend on bottled water per month? **? *(o dirisa bokahe go reka metsi a mabotlele mo kgweding?)***		P.....	
i7	What do you use bottled water for? ***(le dirisetsa metsi a mabotlele eng?)***	Drinking 1 2 Cooking 1 2 General cleaning 1 2 Other:		
J1	Does your household have access to a borehole?	Yes	1	

	(A lelwapa le, le nale sediba se se sedirisang?)	No	2	→**J11**
J2	Who owns the borehole **(Mong wa sone ke mang?)**	Household Neighbour Community Government Not sure Other	1 2 3 4 5 6	
J3	For how long has your household been accessing water from an underground borehole? (Le ntse le dirisa sediba se lebaka le le kae?)			
J4	What type of energy does the borehole system use? **(Sediba se dirisang go bereka?)**	Electricity Diesel Petrol Other	1 2 3 4	 →**J8** →**J8**
J5	Do you pay electricity charges for operating the borehole system? **(A o duela lekgetho la motlakase fa o dirisa sediba?)**	Yes No	1 2	 →**7**
J6	How much electricity are you paying per month for the operation of the pump? **(O duela bokae ka kgwedi?)**	P		
J7	Who is paying for the electricity for the borehole system? **(Ke mang yo o duelang?)**			
J8	Do you buy any fuel (petrol/diesel) for the pump? **(An o reka leokwane la sediba?)**	Yes No	1 2	 →**J10**
J9	How much do you spend per month on fuel (petrol/diesel) for the operation of the pumping system? **(O dirisa bokae ka kgwedi go reka leokwane la Sediba?)**	P		
J10	Who buys fuel for the pumping system? **(Ke mang yo o rekang leokwane?)**			
J11	Does your household have access to water from a surface water pump? **(A lelwapa la gago le nale pompo e e gogang metsi mo nokeng?)**	Yes No	1 2	 → ***K1***
J12	Who owns the surface water pump **(Mong wa pompo ke mang?)**	Household Neigbour Community Government Not sure Other	1 2 3 4 5 6	
J13	For how long has your household been accessing water from a surface water pump? **(Ke lobaka lele kae lo ntse le dirisa pompo e?**			
J14	What type of energy does the surface water system use? **(Le dirisa leokwane lefe go dirisa pompo e?)**	Electricity Diesel Petrol Other	1 2 3	
J15	Do you pay electricity charges for operating the surface water system? **(A o duela le kgetho la motlakase go dirisa pompo e?)**	Yes No	1 2	 →**J17**
J16	How much electricity are you paying per month for the operation of the pump? **(O duela bo kae ka kgwedi?)**			
J17	Who is paying for the electricity for the surface water system? **(Ke mang a duelang?)**			

J18	Do you buy any fuel (petrol/diesel) for the surface water pump? **(A o reka leokwane go dirisa pompo?)**	Yes No	1 2	**→20**
J19	How much do you spend per month on fuel for the operation of the pumping system? **(O dirisa bokae ka kgwedi?)**			
J20	Who buys fuel for the surface water pumping system? **(Ke mang yo o rekang leokwane?)**			
J21	Do you get adequate water from your pumping water system? **(A o bona metsi aa lekaneng mo Sedibeng?)**	Yes No	1 2	
J22	How do you access the water from your pumping system? **(Metsi o a ntsha ka tsela ee ntseng jang?)**	Piped water system inside house Piped system into yard From the pump site Other	1 2 3	
J23	Has the pumping system improved your water supply situation in the home*? **(A go impompela go tokahaditse seemo sa metsi mo lapeng?)***	Yes No	1 2	
J24	Did you spend anything on the installation of the pumping system? **(Aa o dirisitse madi mangwe go gokelela pompo ya sediba?**	Yes No	1 2	**→J26**
J25	How much did you spend on the water pumping system? ***(le dirisitse bokae go tsenya pompo e?)***		P.....	
J26	Do you spend some money on the operation and maintenance of the system? **(A go nale madi mangwe go bakanya pompo ya sediba?**	Yes No	Yes No	**→28**
J27	How much do you spend per annum on the operation and maintenance of the water pumping system? ***(le dirisa bokae mo ngwageng go tlhomamisa gore sediba se nna se le mo tirisong?)***		P.....	
J28	Do you have neighbours and friends coming to fetch water from your pumping system**? *(a go na le baagisanyi le ditsala ba ba gelelang metsi mo Sedibeng sa gago?)***	Yes No	1 2	**→J32**
J29	How often do they come? ***(ba tla ga kae go gelela metsi?)***	Daily Weekly Fortnightly Othe	1 2 3 4	
J30	How many households are you assisting with water from your pumping system**? *(le thusa malwapa a le kae ka metsi?)***		.....	
J31	Do they help you with energy bills and maintenance of the pump**? *(a ba le thusa go duela motlakase le paakanyo ya sediba?)***	Yes No	1 2	
J32	Do you have a permit for pumping water? ***(A o na le teseletso ya go pompa metsi?)***	Yes No Not sure	1 2 3	
J33	Do you pay any annual levies for operating the pumping system**? *(a gona le lekgetho le o le duelang go dirisa sediba?)***	Yes No	1 2	**→K1**
J34	How much are you paying**? *(o duela bokae?)***		P.....	
K1	Do household members experience misunderstandings over the use of water stored in the house**? *(a gona le dikgothang dingwe mo lwapeng tse di bakiwang ke go bewa ga metsi mo ntlong?)***	Yes No	1 2	**→K3**

K2	What type of misunderstandings are these**?** ***(ke dikgothang tsa mofuta mang?)***	Usage of water Amount to be used Allocation criteria Other	1 2 3 4	
K3	Where do you store the water you collect in times of shortages in your home**?** ***(Fa gona le thaelo ya metsi mo lwapeng le baya kae metsi a le a gileng?)***	100L container 50L containers 20L plastic containers 20L metal containers 10L plastic containers 10 metal containers 5L plastic containers 5L metal containers Other	1 2 3 4 5 6 7 8 9	
K4	How many of these containers do you have**?** ***(le na le dibeelo tsa metsi di le kae?)***	100L container 50L containers 20L plastic containers 20L metal containers 10L plastic containers 10 metal containers 5L plastic containers 5L metal containers Other	.... 	
K5	Who is mainly responsible for ensuring the safe keeping of water within the household? ***(ke mang mo lwapeng yo o tlhokomelang gore metsi a beilwe sentle?)***	Female members >18yrs Male members >18 yrs Female members 12 – 17 yrs Male members, 12 – 17yrs Children, 5 – 11 yrs All mature household members Others	1 2 3 4 5 6 7	
K6	Who is mainly responsible for ensuring the allocation of the water for different uses*?* ***(ke mang yo o tlhokomelang gore go dirisiwa ga metsi?)***	Female members >18yrs Male members >18 yrs Female members 12 – 17 yrs Male members, 12 – 17yrs Children, 5 – 11 yrs All mature household members Others	1 2 3 4 5 6 7	
K7	Do you have a household member responsible for allocating water stored in the home? ***(A go na le yoo laolang tisiriso ya metsi a a beilweng mo lapeng?)***	Yes No	1 2	
M1	Which three activities do you prioritize in times of water problems*?* ***(ke dife ditiro tse tharo tsa konokono tse le di dirisang ka nako ya tlhaelo ya metsi?)*** ***(Circle three activities only)*** ***(Tsenya tse tharo mo lesakaneng)***	Cooking Drinking Bathing Hand washing General Cleaning Laundry Garden watering Swimming pool Small livestock watering Other	1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2	
M2	Does the amount of water in the household determine whether one should bath or not? ***(A seemo sa metsi se laola gore le tlhapa ga kahe?)***	Yes No	1 2	
M3	How many litres do the following member of the household need to bath when there is no water problem? ***(batho ba ba latelang ba dirisa dilithara***	Male adults Female adults Children	……L ……L ……L	

	tse kae go tlhapa mo letsatsing fa go sena thaelo ya metsi?)			
M4	How many litres do the following members of the household need to bath when there is a water problem? ? ***(batho ba ba latelang ba dirisa dilithara tse kae go tlhapa mo letsatsing fa go na le thaelo ya metsi?)***	Male adults Female adults Children	……L ……L ……L	
M4.1	When there is an acute water shortage do household members sometimes skip bathing? **(Aa le atle le tlhoke go tlhapa fa go sena metsi mo lapeng?)**	Yes No	1 2	
M5	How often is laundry done within your household when there are no water problems*?* ***(le tlhatswa diaparo ga kae fa go sena letlhoko la metsi?)***	Everyday Twice a week Once a week Other	1 2 3 4	
M6	How often is laundry done within your household when there is a water problem? ***(le tlhatswa diaparo ga kae fa gona le letlhoko la metsi?)***	Everyday Twice a week Once a week Other	1 2 3 4	
M7	Where do you mainly do your laundry when there is a water problem*?* ***(le tlhatswa diaparo ga kae fa gona le letlhoko la metsi?)***	Home River/Stream Public Tap Unprotected Well Other	1 2 3 4 5	
WATER QUALITY				
N1	Do you store water for drinking in the house? ***(a o baya metsi a go nwa mo ntlung?)***	Yes No	1 2	**→N5**
N2	What type of containers do you store you water in? ***(o baya metsi mo go eng?)***	Narrow-mouthed Wide mouthed Of both types	1 2 3	
N3	Where do you place the containers with drinking water? ***(le baya fa kae dibeelo tsa metsi aa nowang?)***	On the floor Elevated above the floor Floor and elevated above the floor	1 2 3	
N4	Who takes water from these containers? ***(ke mang yo o gang metsi mo dibeelong tse?)***	Adults School aged children Children under 5 Anyone within the household	1 2 3 4	
N5	How do you remove water from the drinking water container? ***(le ga metsi jang mo dibeelong?)***	Pouring Dipping Both pouring and dipping Container has a spigot	1 2 3 4	
N6	What can you say about the quality of the water from your main source whenever it is available*?(le ka reng ka boleng jwa metsi go tswa ko le a gang teng?)*	Good Bad Don't know	1 2 3	
N7	What can you say about the state of the water from your main source? ***(O ka reng ka boleng jwa metsi ko le a gelelang thata teng?)***	Good Smells bad discoloured Bad taste Other	1 2 3 4 5	
N8	What can you say about the state of the water from your alternate source? ***(O ka reng ka seemo jwa metsi ko le a gelelang thata teng?)***	Good Smells bad discoloured Bad taste Other	1 2 3 4 5	
N9	Do you treat your drinking water from your regular source in any way to make it safer*?* ***(A le tle leke go tokafatsa seemo sa metsi ko le a geleleng thata***	Yes No Don't know	1 2 3	

	teng?			
N10	Do you treat your drinking water from your alternate source in any way to make it safer? ***(A le tle leke go tokafatsa seemo sa metsi go tswa mo mafelong a mangwe?***	Yes No Don't know	1 2 3	 **→ O1** **→ O1**
N11	What do you usually do to the water to make it safer to use? ***(Le tle dire eng go tokafatsa seemo sa metsi?***	Boil Add bleach/chlorine Strain through a cloth filter using sand Let it settle Don't know Other	1 2 3 4 5 6 7	
N12	How do you dispose of water that has been used for washing dishes, doing laundry, and bathing? ***(Metsi a le dirisitse go tlhatswa dijana, diaparo le go tlhapa le a isa kae?***	Pour into toilet facility Pour on empty space in yard Water fruit trees or garden Other	1 2 3 4	
SANITATION				
O1	What kind of toilet facility do members of your household usually use? ***(ke mofuta ofe wa ntwana ya boitiketso oo dirisiwang mo lelwapeng?)***	Flush inside house Ventilated improved pit latrine (VIP) Pit latrine with slab Bush Bucket Other	1 2 3 4 5 6	 **→O5** **→O5** **→O7** **→O7** **→O7**
O2	Do you use the facility when you have a water problem? ***(a le e dirisa fela le fa go sena metsi?)***	Yes No	1 2	 **→ 04**
O3	How do you flush the toilet after use when you have a water problem? ***(Le dirisa eng go eledisa leswe ha go na le letlhoko la metsi ?)***	Use a bucket to flush after each use Flush after using several times	1 2	
O4	What alternative toilet facility do you use when you have a water problem? ***(ke ofe mohuta wa itiketso o le o dirisang ha go sena metsi?)***	Ventilated improved pit latrine (VIP) latrine with slab Bush Bucket Other	1 2 3 4 5	
O5	Do you clean your toilet facility when there is no water problem? ***(a o phepafatsa didirisiwa tsa ntlwana ya boiteketso fa go sena bothata jwa metsi?)***	Yes No	1 2	
O6	Do you clean your toilet facility when there is a water problem? ***(a o phepafatsa didirisiwa tsa ntlwana ya boiteketso fa go na le bothata jwa metsi?)***	Yes No	1 2	
O7	Do all household members wash their hands after relieving themselves?	Yes No	1 2	
APPLICATION OF IWRM PRINCIPLES				
P1	Do you know of water policies which highlight issues of water access to households?***(a o itse ka ka ditsamaiso dingwe tse di amanang le go isiwa ga metsi ko malapeng?)***	Yes No	1 2	 ***→P3***
P2	What is the major provision of these policies**?** ***(Ke ofe molawana tsamaiso wa konokono mo go tsone?)***	Access to water for everyone Water has to be provided for free People have to pay for water Other	1 2 3 4	
P3	Are you aware of the institutions involved in water management in the country? ***(a le itse makalana a okametseng tsamaiso ya metsi mo lefatsheng?)***	Yes No Not sure	1 2 3	 ***→P5*** ***→P5***
P4	Which institutions are responsible for water resources management in the country? ***(ke afe makalana a okametseng tsamaiso ya metsi mo lefatsheng?)***	Department of Water Affairs Water Utilities Corporation District Councils Other	1 2 1 2 1 2	

P5	Are you aware of the responsibilities of this/these institution/s? ***(a o itse ditiro tsa makalana a?)***	Yes No Not sure	1 2 3	 →***P7*** →***P7***
P6	What are the responsibilities of these institutions in water supply*?* ***(ditiro tsa makalana a ke dife?)***			
P7	Do households have any representation in issues related to water supply*?* ***(a banni ba na le kemedi mo dikganyeng tse di amanang le metsi?)***	Yes No Not sure	1 2 3	 →***P11*** →***P11***
P8	Who represents you in water supply issues? ***(Ke mang yo o le emetseng mo dikgannyeng tse di amanang le metsi?)***	Member of Parliament Councillor Chief Village head Village Development Committee Other	1 2 3 4 5 6	
R9	On what issues have you been represented? ***(Ke mo dikgang dife tse leneng la nna le kemedi?)***	Water Supply Water quality Other	1 2 1 2	
P10	How effective are your representatives? ***(kemedi ya lona ke e kgona go le kahe?)***	Very effective Not effective	1 2	
P11	Would you like someone to represent you in issues related to water supply? **(a le eletsa go nna le Moemedi mo dikgannyeng tse di amanang le metsi?)**	Yes No Not sure	1 2 3	
P12	Do you think households can play a role in water supply and distribution**?** ***(a o akanya gore malwapa a ka nna le seabe mo dikganyeng tse di amanang le go anamisa metsi?)***	Yes No Not sure	1 2 3	 →***P14*** →***P14***
P13	How could they play a role in water supply**?** ***(ba ka nna le seabe sa eng mo kanamisong ya metsi?)***	Set up forums for participation Providing ideas to the service provide Propose affordable water charges Other	1 2 3 4	
P14	Have you ever been consulted on issues related to household water supply by relevant authorities**?** ***(a le kile lwa rerisiwa ka dikgang tsa metsi ke ba makalana a a okametseng metsi?)***	Yes No	1 2	 →***P17***
P15	On what issues have you been consulted**?** ***(ke dikgang dife tse loneng lwa di rerisiwa?)***	household water supply Water pricing Other	1 2 3	
P16	How are you consulted**? (*le rerisiwa jang?)***	Through meetings Councillor Chief Kgotla Other	1 2 3 4 5	
P17	Do you have a forum where you discuss water supply issues in your settlement**?** ***(a le na le bokopano bongwe jo le bo tshwarang go bua ka kanamiso ya metsi mo motseng?)***	Yes No	1 2	 →**P21**
P18	Who organizes this forum**?** ***(ke mang yo a rulaganyang bokopano jo?)***	Service provider Councillor Chief Kgotla Other	1 2 3 4 5	
P19	What specific issues are discussed at this forum*?* ***(ke dife dikgang tsa konokono tse di buiwang kwa bokopanong jo?)***	Reliable water supply Water pricing Other	1 2 3	
P20	Has your forum ever had any impact on water supply in this settlement? ***(A bokopano jo bo nniletlisitse phetogo mo kanamisong ya metsi?)***	Yes No	1 2	

P21	Are you paying for the household water you are using*? **(a o duelela metsi a o a dirisang mo lwapeng?)***	Yes No	1 2	 **→*P32***
P22	How much are you paying per month? ***(o duela bokae ka kgwedi?)***		P.....	
P23	Where do you pay your water charges? ***(o duelela metsi kae?)***	District Council Water Affairs Other	1 2 3	
P24	Why are you paying what you are paying? ***(Keng o duela tlhwatlhwa e e kalo?)***	To receive water It's a govt requirement Don't know Other	1 2 3 4	
P25	Are you satisfied about the amount that you must pay? ***(a o kgotsofalela dituelo tse o di duelang ?)***	Yes No Not sure	1 2 3	 **→*P27*** **→*P28***
P26	Why do you say you are satisfied? ***(Keng o re o a kgotsofala?)***	Payment guarantees fair allocation The payment is reasonable Other	1 2 3	
P27	Why are you not satisfied? ***(keng o sa kgotsofale?)***	Charges are too much Never involved in setting the charges Any payment not justified Other	1 2 3 4	
P28	Who set the water charges? ***(Ke mang yo o bayang ditlhwatlhwa tsa metsi?)***	Central government Department of Water Affairs District Council	1 2 3	
P29	Are you consulted before new charges are effected*?**(a le a bolelwa fa go fetolwa ditlhwatlhwa?)***	Yes No	1 2	 **→P31**
P30	How are you consulted? ***(o bolelelwa ka jang?)***	Through public meetings through the councillor through the chief Through the VDC Through the MP Other	1 2 3 4 5 6	
P31	Why do you think you are not consulted? ***(o akanya gore keng o sa bolelelwe?)***	Not important Not necessary Don't know Other	1 2 3 4	
P32	If you are not paying for the water that your household is using, what is your main reason? ***(ga o sa duele metsi a o a dirisang mo lwapeng ,lebaka la gago ke lefe?)***	No piped water supply Water bills are not coming Government supplies water for free Water supply should be for free Don't know Other	1 2 3 4 5 6	
P33	Are there any improvements which you would like to see in domestic water supply and distribution? **(*a gona le dilo dingwe tse di ka dirwang go tokafatsa go anamisa metsi mo motseng?)***	Yes No Not sure	1 2 3	***End interview*** ***End interview***
P34	What major changes would you like to see in household water supply for domestic use? ***(ke diphetogo dife tse o ka ratang go dibona mo kanamisong ya metsi?)***	Reliable supply of water Better Quality water Affordable water charges participation in water supply Other	1 2 3 4 5	

Thank respondent

End time_____

ANNEX 3: KEY INFORMANTS GUIDES

Hydrological issues for discussion – Department of Water Affairs Hydrology Section, Maun Station

- What are the roles and responsibilities of the Water Affairs hydrology section in water supply and distribution in the North West District area?
- How big is this section in terms of personnel, budget and equipment?
- What is the annual budget of the section and is this adequate?
- How many personnel does the section have (if you could attach diagram of the section)?
- What critical equipment does your section have and is this adequate?

Hydrology of the district

- Could you please in simple terms describe the hydrology of Ngamiland?
- What has been the influence of hydrological factors to availability (surface and ground water) water supply in Ngamiland in general and to Maun, gazetted villages and ungazetted villages over the last 30 years?
- Where is the bulk of the District water resources found – surface or ground?
- What hydrological factors are responsible for the current water shortages in Maun and other settlement?
- What measures is your section adopting in order to address the current water shortages in the district?
- Does your section have data on the annual renewable surface and groundwater resources in Ngamiland?
- How sustainable are the districts' groundwater reserves?
- How many private homes have boreholes?
- Where are most of the private boreholes?

Water distribution issues for discussion – Water Distribution Manager, Department of Water Affairs

Issues for discussion

- Role of Water Affairs in water supply and distribution in Ngamiland
- Budget allocation for Ngamiland, Department of Water Affairs (Its in/adequacy)
- Water distribution coverage for Maun
- Areas with constant supply and those with shortages
- For how long have the shortages been persisting
- Major factors behind the shortages
- General water quality of Maun (the water quality of groundwater as compared to surface water

Water bousing

- How many water tankers does Department Water Affairs have and their capacity?
- When did the tankers started distributing water?
- Where do they supply water?
- Can the takers supply water to private homes and at what cost?
- What is the monthly running costs for the water tankers

Water collection points for residents

- How many jojos does DWA have in Maun placed at strategic points?
- How often are these filled with water?
- How are residents coping and adapting to water shortages

Reactions from residents

- How do residents feel generally about water distribution in terms of consistence of supply, quality and quantity?
- How do residents feel about current water shortages
- How does WA communicate with residents on issues related to water supply and distribution
- Are there are forums for residents to participate in water supply and distribution

Water pricing

- Water charges which residents pay
- Relevance of the water charges as compared to supply and distribution costs

Supply and demand

- Current demand and supply for Maun

Human Resources

- Adequacy of human resources especially technical staff responsible for supply and distribution

Water supply issuese for discussion – Water Distribution Manager, Department of Water Affairs, Maun Station

Issues for discussion

Management and financial matters

- What does water supply to Maun mainly involve
- How many technical personnel does the water supply section have and is this adequate?
- What has been the annual budget allocation for water supply section for the past 5 years (It's in/adequacy) – I would appreciate copies of the budgets

Infrastructure equipment

- How best can you describe the state of Maun water supply infrastructure?
- What additional infrastructure is required?
- What critical equipment does the section have and is this adequate

Water supply and demand overtime

- Can you please provide information on water demand for Maun against supply and population growth for the last thirty years or as far as your records can show?
- Water shortages being currently experienced by Maun, point to problems in supply, for how long has the Maun been experiencing water supply problems?
- Major factors behind the water supply problems?
- What is the general water quality of Maun (the water quality of groundwater as compared to surface water)?

- Has the Wenela Treatment plant been upgraded?
- Has the proposed surface water treatment plant at Maun General Hospital now under construction?
- How much surface water will be supplied to this plant for treatment from Thamalekane river?
- Has the department contracted embankments around the boreholes in the flood prone areas.
- Does the construction of embankments assist in better water supply to Maun?
- Are there any prospects of the Maun Phase II water and sanitation project being carried out?
- What are the details of this particular project?

Short-term water supply measures

- Short-term measures highlighted in your water supply situation report point limited sources within 100km of Maun, what would the alternative then in order to improve water supply?

Long term water supply measures

- Could you please provide more information on the Maun Integrated Water Scheme Up-grade Scheme.

Water quality issues for discussion – Water Quality Manager, Department of Water Affairs, Maun Station

- What are the roles and responsibilities of the Water Affairs water quality section in water supply and distribution in the North West District area?
- How big is this section in terms of personnel, and budget?
- What is the annual budget of the section and is this adequate?
- How many personnel does the section have (if you could provide diagram of the section)?
- What critical equipment does your section have and is this adequate?
- How many water treatment plants are directly under your section?
- How many of the water treatment plants are functional?
- If there are any water treatment plants that are not functional, what is the problem and how long have they not been functional?
- How much water can be treated at each of the water treatment plants on a daily basis?
- Which water need more treatment – surface or underground?
- Is the department treating both surface and underground water?
- Is all the water being supplied to the residents treated?
- How do you rate the water that your department treat?
- In the context of the current water shortages, how safe is the water that the residents are using especially from Thamalekane River?
- What should the residents do in order to make the water from sources such as Thamalekane River safe to drink?

Interview guide – ward councillors

- For how long have you been the councillor of this ward?
- What is the current population in your ward?
- What was the population in 2001?

- What are the three major problems which you can say your ward is experiencing?
- What are the major water sources for households?
- How reliable has been household water supply within the last ten years?
- When did your ward start experiencing current water shortages?
- How severe have been the current water shortages?
- The ward can go for a maximum of how many days without water?
- Where do residents get water in the event of severe water shortages?
- What are the causes of the current water shortages?
- What explanation has been given by Water Affairs with regards to the current shortages?
- What has water Affairs done in order to alleviate the current water shortages?
- Do you think Water Affairs is doing enough to alleviate the water shortages?
- What is your council doing in order to ensure that residents have uninterrupted water supply?
- What do you think has to be done for the whole of Maun in terms of water supply?
- How good is the quality of the water being supplied by Water Affairs to residents?
- Do residents do anything to the water to make it safer to use?
- What has been the reaction of the residents to the current water shortages since they are supposed to be paying for the water?
- Do residents have a say in the management and supply of water?
- Do residents have a fora where they talk water supply and distribution issues with Water Affairs officials?
- Do you think residents should have a say in the management and supply of water?
- How could they make an input in this regard?
- What can you say about the water charges by Water Affairs – are they high, average or low?
- Do you think residents should pay for water when they are experiencing water shortages?
- What should be the role of the central government in water supply and distribution?

Interview guide – Water Utilities Corporation officials, Ngamiland District

Household water supply,

- What has changed in terms of water supply since you took over in Ngamiland, e.g. in Maun, Matlapana and pan-handle area?
- Why is it that other areas still experience water shortages more than a year since you took over?
- What are long-term solutions for remote settlements like Somelo?
- Does the utility has any plans for supplying water to ungazetted villages like what was done by the Okavango Admin Authority?
- How is the Utility going to charge those accessing water from public standpipes both in gazetted and ungazetted villages?
- How many settlements are still having water bowsed to them by the WUC?
- What are the costs related to water bowsing on the part of WUC?

Water governance structure for WUC nationally and in Ngamiland ?

- What is the water governance/supply structure of the WUC?
- How appropriate/effective is this structure for practical water supply purposes?
- Would you have an alternative structure?
- How relevant is IWRM for Botswana
- Is the WUC adopting any IWRM principles e.g. stakeholder participation and water as an economic good?
- What forums are used by the WUC in its consultations with its stakeholders?
  What changes do you think are needed in the water policy and legislation for Botswana?

Challenges being encountered by your Corporation as well as your

- What are the major challenges being experienced by WUC in Ngamiland?
- How are you trying to address these challenges?
- Does the WUC in Ngamiland have adequate human resources in all the key sections?

- Does the WUC in Ngamiland have adequate materials resources needed for water supply, e.g. vehicles etc?

Water pricing

- How economic is your water pricing regime?
- Do you always need government approval to change the water pricing structure?
- Are there any plans to change the water pricing regime in Ngamiland?
- How effective is the WUC in the collection of revenue?
- How does the WUC deal with defaulters?
- What happened to those households which were defaulting under Department of Water Affairs and the District Council?

Reports
Can I have access to your reports for Ngamiland, e.g. monthly, quarterly etc

Interview guide – Village Development Committee Members

- For how long have you been a member of the village development committee (VDC)?
- What is the current population of your village?
- What was the population in 2001?
- What are the three major problems which you can say your village is experiencing?
- What are the major water sources for households?
- How reliable has been household water supply within the last ten years?
- When did your village start experiencing current water shortages?
- How severe have been the current water shortages?
- The village can go for a maximum of how many days without water?
- Where do residents get water in the event of severe water shortages?
- What are the causes of the current water shortages?
- What explanation has been given by Water Affairs/District Council with regards to the current shortages?
- What has Water Affairs/District Council done in order to alleviate the current water shortages?
- Do you think Water Affairs/District Council is doing enough to alleviate the water shortages?
- What is your councillor doing in order to ensure that residents have uninterrupted water supply?
- What do you think has to be done for the village in terms of water supply?
- How good is the quality of the water being supplied by Water Affairs/District Council to residents?
- Do residents do anything to the water to make it safer to use?
- What has been the reaction of the residents to the current water shortages?
- Do residents have a say in the management and supply of water?
- Do residents have a fora where they talk water supply and distribution issues with Water Affairs officials?
- Do you think residents should have a say in the management and supply of water?
- How could they make an input in this regard?
- What can you say about the water charges by Water Affairs – are they high, average or low?
- Do you think residents should pay for water when they are experiencing water shortages?
- What should be the role of the central government in water supply and distribution?

ANNEX 4: FOCUS GROUP DISCUSSION GUIDE

Water security guiding issues for discussion

Background issues

- What is the brief history of this settlement?
- What are the major economic activities in this settlement
    - Which economic activities are done by men, women and youths?
- Where did households get water from in the past 20 years?
- What are the major sources of water for households in this settlement now?
- What is your definition of water security?
- What is your definition of water insecurity?

Factors behind water security problems and trends in water use

- Has water been adequate for different household uses within the last 20 years?
- What challenges are being faced in this settlement with regards to water supply for domestic use?
    - How is the quality of the water you are drinking
    - Do you get adequate water from your water source
    - Is water available all year round since 1980 etc
    - Do people of all age groups have access to the water source
    - Do everyone have access to water anytime of the day
    - Are there any problems encountered when getting water during daylight and in the evening?
- When did this village start experiencing water problems?
- What are the causes of the water problems which this village is experiencing?

Coping and adaptation strangers and gender and social relations

- When there is water shortage, where do households get water for domestic use?
- Is this water you get in times of shortages safe?
- Who within many households, who is responsible for fetching water during times of shortages?
    - Which age groups fetch water?
    - What type of containers are used to fetch water by women, men, girls and boys?
    - How much time can women, men, girls and boys spend for fetching water on a particular day?
    - What mode of transport is used by women, men, girls and boys to transport water to homesteads? E.g. head, hands, scotch cart etc and why?
    - How much water can women, men, girls and boys fetch on a single trip?
    - What times do men, women, boys and girls usually go to fetch water?
    - How many times a day do different groups go to fetch water?
- Are there any households practicing rainwater harvesting?
- Why are these households harvest water?
- For how long has rainwater harvesting been practiced in this settlement?
- What types of containers are used to harvest water?
- Does rainwater harvesting help in alleviating water problems in the community
- If households in the community are not harvesting water, why is this not being done?
- *How do you think the water problem in Matlapana can be solved?*

Water governance issues

- Do officials from the district councils ever come to your village to discuss water supply and quality issues?
- If they come how often do they come?

- Have you ever give your suggestions on you're the water problem in this village can be solved to these officials?
- Does the VDC, ever discuss water supply issues with the villagers
- Does the Councilor ever discuss water supply issues with the villagers
- Does the Kgosi ever discuss water supply issues with the villagers
- What help have the VDC offer in the light of the prevailing water shortages?
- What help have the Councilor offer in the light of the prevailing water shortages?
- What help have the Kgosi offer in the light of the prevailing water shortages?
- Do you think the Council is doing enough to solve this water problem?
- Why do you say so?
- What should the council do to solve this water problem?
- Are community members aware of policies related to water management?
- If so, can the provision of these policies be spelt out?
- Who is responsible for the management of water that you use for domestic purposes?
- Who is responsible for the management of water resources at the settlement level?
- What major changes would the community want to see in household water supply?
- What major changes do would men like to see in water supply?
- What major changes do women like to see in water supply?