DEVELOPING INTEGRATED MANAGEMENT OF EPHEMERAL RIVER BASINS IN BOTSWANA: THE CASE OF BOTETI RIVER SUB-BASIN

by

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DECLARATION

I **Moseki Ronald Motsholapheko** declare that **Developing Integrated Management of Ephemeral River Basins in Botswana: The Case of Boteti River sub-Basin** is my own work and that all sources that I have used or quoted have been indicated and acknowledged by means of complete references. The thesis has not been submitted to any other university or institution for the award of a degree.

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ABSTRACT

Botswana is a water scarce country. Rainfall is highly variable, leading to limited surface and groundwater resources. Due to persistently dry conditions most rivers found in Botswana are ephemeral. The Boteti River sub-Basin is one of the numerous ephemeral river sub-Basins, in Botswana. Key environmental challenges, resulting from human activities, in the sub-Basin are: increased pressure on local resources due to overstocking, overgrazing and over-harvesting; reductions in wildlife numbers; denudation of vegetation and the resultant exposure of the soil to wind erosion. As a major step, to pilot implementation of river basin management in the ephemeral river basins in southern Africa, the Boteti River sub-Basin is one of the key areas identified for study under the Ephemeral River Basins in the Southern African Development Community SADC (ERB-SADC) Project. This study was initiated, as part of the ERB-SADC project and its aim is to investigate the socio-economic status of the Boteti River sub-Basin and determine the potential for developing integrated management of water and land resources in the sub-Basin. Its key objectives are to identify and assess types and patterns of water use; to identify and assess key livelihood activities; and to critically assess community participation in water resources management in the sub-Basin. A questionnaire was administered to 293 households, a focus group discussion was held with twelve community representatives of six villages in the sub-Basin, six traditional leaders and five local government officers were interviewed as key informants, and informal discussions were held with three local farmers. Results from the study indicate low livelihood levels based on livestock and arable agriculture, high dependence on natural resources and low participation of communities in water management. The study concludes that a livelihood approach to integrated water resources management can help deal with environmental challenges and enhance community participation.

Key words: Integrated water resources management, river basin management, Boteti

River, ephemeral rivers, Botswana, livelihoods.

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DEDICATION

This work is dedicated to my late father Gasebatho Motsholapheko. His greatest love of education for all his children will forever serve as inspiration to all of us. I also dedicate this space to my mother Milana Motsholapheko, her determination to see us through to maturity can never be far from my heart. More dedication goes to my brothers and sisters who have provided all the moral, social and collective support and inspiration that saw me through this project. Finally, the best goes to my wife Kebadirile, and my two sons Tshepho and Lesedi.

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ACRONYMS AND ABBREVIATIONS

CSO	Central Statistics Office
CKGR	Central Kalahari Game Reserve
DA	District Administration
DC	District Council
DESIRE	Desertification Mitigation and Remediation of Land Project
DRFN	Desert Research Foundation of Namibia
EA	Enumeration Area
ELAK	Environmental Learning and Action in the Kuiseb
ERB-SADC	Ephemeral River Basins in SADC Project
FIRM	Forum for Integrated Resources Management
GWP	Global Water Partnership
HOORC	Harry Oppenheimer Okavango Research Centre
ICPD	International Conference on Population and Development
IWRM	Integrated Water Resources Management
NGO	Non-Governmental Organisation
ODMP	Okavango Delta Management Plan
PTA	Parents and Teachers Association
RADP	Remote Area Development Programme
R-WASHE	Rural Water Supply Sanitation Health Education Committee
SADC	Southern African Development Community
SADC-WSCU	SADC Water Sector Coordinating Unit
SMEC	Snowy Mountains Engineering Corporation (Ltd)
TLA	Tribal Land Act
UN	United Nations Organisation
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
VDC	Village Development Committee
VHC	Village Health Committee
V-WASHE	Village Water Supply Sanitation Health Education Committee
WSSD	World Summit on Sustainable Development

CHAPTER 1: INTRODUCTION

1.1 GENERAL BACKGROUND

Botswana is generally semi-arid to arid with average annual rainfall ranging from 250 mm/year in the south west to 650 mm/year in the north eastern tip (Snowy Mountains Engineering Corporation Ltd [SMEC], 1991). The country is water scarce, since the meagre rainfall received is highly unreliable, droughts are common, surface water resources are very limited and groundwater recharge is very low (Arntzen & Kgathi, 2005). Due to persistently dry conditions in the country, caused by unreliable rainfall and persistent drought, most rivers found in the country are ephemeral, experiencing short term water flows each year (Clayton, 1995). It is therefore essential to adopt water management approaches that are more suitable to the generally ephemeral nature of most rivers found in Botswana.

The Boteti River sub-Basin is one of the numerous ephemeral river sub-Basins found in Botswana. It is part of the larger Okavango River Basin, found in the south eastern part of the Okavango Delta, a Ramsar site of international importance. It is the main connecting point between the larger Okavango Delta and Makgadikgadi salt pans in north-central Botswana (Kgathi *et al.*, 2006).

The sub-Basin experiences semi arid to arid conditions. However, it serves as a support pillar for various forms of livelihood activities such as: livestock and dryland arable farming; veld products collection; tourism; fishing; *molapo* or flood recession cultivation and wilderness conservation, in the two game parks of Makgadikgadi National Park, in

the east, and the Central Kgalagadi Game Reserve (CKGR) in the west. Surface water resources are currently limited and mostly found in the wetter upstream of the Boteti River and Makgadikgadi Pans. Most livelihood activities depend on ground water resources. In addition, the diamond mining operations in Orapa depend mainly on the groundwater resources in the southern part of the sub-Basin (SMEC, 1991; Arntzen, *et al.*, 1994; Vanderpost, 1995; Hydrogeo (Pty) Ltd and Water Surveys (Botswana), 2001; Scott Wilson Kirkpatrick and Partners & Ecosurv (Ltd), 2002) (See Figure 1 below).

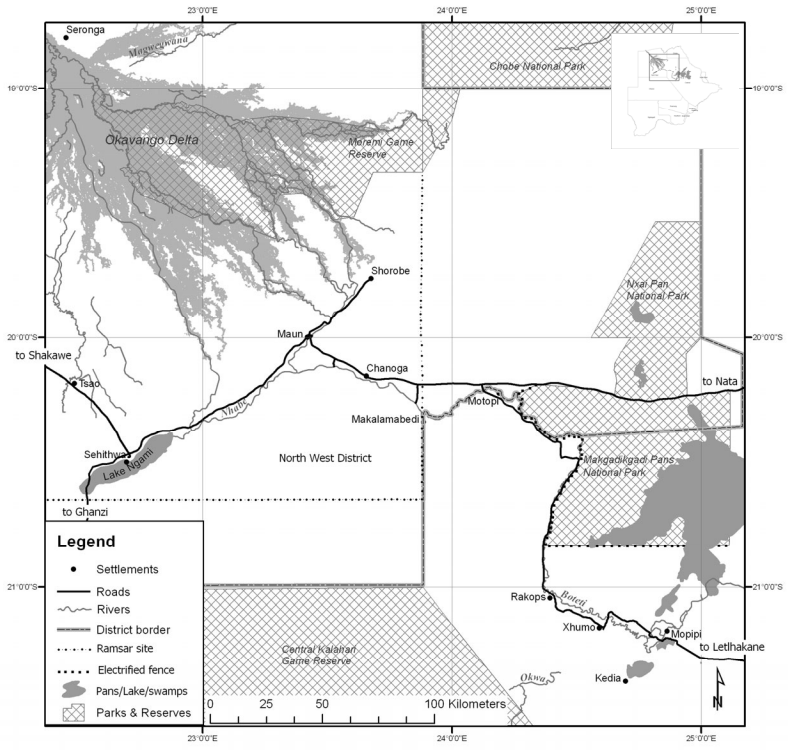

Figure 1: Map showing parts of the Okavango Delta Ramsar Site and the electrified fence around Makgadikgadi National Park

Source: Harry Oppenheimer Okavango Research Centre [HOORC], (2006).

Key environmental challenges, resulting from human activities, in the sub-Basin are: increased pressure on local resources due to overstocking, overgrazing and over-harvesting; reductions in wildlife numbers; denudation of vegetation and the resultant exposure of the soil to wind erosion. Current management practices only serve to exacerbate the effects of these challenges (Arntzen *et al.*, 1994; Vanderpost, 1995).

In the early 1990s the mid-Boteti, part of the sub-Basin, was earmarked as a case study to support Botswana's contribution to the Intergovernmental Convention on Desertification (Arntzen *et al.*, 1994). In another major step, contributing to the United Nations Convention to Combat Desertification (UNCCD) objective of combating desertification, the sub-Basin is now one of the key areas identified for study under the Ephemeral River Basins in SADC Project (ERB-SADC), of which this study is part. The ERB-SADC project seeks to assess the potential of community driven development in selected ephemeral rivers in southern Africa (Desert Research Foundation of Namibia [DRFN], 2005). Other case studies in the project include the Fish River in Namibia, and the Buffels River in South Africa. It is for these reasons that the Boteti River sub-Basin becomes the centre of focus for this study. This study was conducted in the Boteti sub-Basin, with an ultimate view to enhancing the sustainable, equitable and improved management of water and terrestrial resources in the sub-Basin.

1.2 RATIONALE/MOTIVATION FOR THE STUDY

Much of the Boteti River has not had annual water flow from the Okavango Delta in many years and this has implications for water availability, particularly the likelihood of increased "scarcity and heightened competition for its use" (Scott Wilson Kirkpatrick and Partners & Ecosurv (Ltd), 2002). The river serves as a support pillar for various forms of

livelihood activities. Major forms of livelihoods found in its sub-basin include livestock and dryland arable farming, veld products collection, fishing and *molapo* farming or flood recession cultivation, now mostly found in the wetter parts of the sub-basin (Vanderpost, 1995). The Boteti River sub-basin is home to large numbers of cattle as well as wildlife (Scott Wilson Kirkpatrick and Partners & Ecosurv (Ltd), 2002).

Owing to insufficient surface water resources for the largest part of the sub-basin many boreholes have been drilled and hand dug wells sunk in and around the river to supply water for settlements as well as livestock (Vanderpost, 1995; Hydrogeo (Pty) Ltd and Water Surveys (Botswana), 2001). Available surface water resources, especially in the pans and along ephemeral lagoons and ponds are a source of conflicts ranging from wildlife-human, to livelihood based ones such as those between tourism activities and communal livestock farming and subsistence veld products collection and livestock ranching (Scott Wilson Kirkpatrick and Partners & Ecosurv (Ltd), 2002). Worthy to note is the recent construction of the game proof electrified fence around the Makgadikgadi Pans National Park and the proposed declaration of the entire Makgadikgadi system as Botswana's second (after the Okavango Delta) wetland of international importance under the Ramsar Convention (Scott Wilson Kirkpatrick and Partners & Ecosurv (Ltd), 2002; Ecosurv, 2008).

In constructing the game proof fence around Makgadikgadi Pans National Park, the government was responding to intense wildlife-human conflicts resulting from the prolonged drying of the Boteti River (Scott Wilson Kirkpatrick and Partners & Ecosurv (Ltd), 2002; Ecosurv, 2008). The river used to provide a buffer between the park and the neighbouring communal grazing area. The fence was seen as the most effective solution

though it reduced grazing pastures as well as watering points for livestock. Currently, the remaining communal grazing land is sandwiched between the Central Kgalagadi Game Reserve (also fenced) in the west and the Makgadikgadi Pans National Park in the east (in Figure 1 above). The declaration of the Makgadikgadi Pans system as a Ramsar site has inherent implications for water use including the development of a major management plan that will focus on the system as a wetland of international importance.

This study therefore will provide more understanding of the socio-economic activities in the sub-Basin contributing to the development of integrated water resources management initiatives. Several studies have been conducted in the sub-Basin and the findings remain anecdotal and fragmented in various reports, most of which do not accord particular emphasis to developing integrated management of water and land resources. The study will serve as a stepping stone for the development of a forum for integrated river basin management in the Boteti River sub-Basin as well as identifying prospects for replication of such systems in other ephemeral rivers in Botswana. It will also add to a larger body of knowledge on the subject of integrated water resources management and sustainable use. It will further contribute to ongoing work started under the Okavango Delta Management Plan (ODMP) project that aims to develop and implement an integrated management plan for the Okavango Delta.

1.3 WORKING HYPOTHESES

Two main assumptions will serve as working hypotheses of the study:

Hypothesis 1: Current management practices contribute to general environmental degradation in the sub-Basin.

Hypothesis 2: Residents of the sub-Basin have the will and capacity to manage their resources.

1.4 AIM AND OBJECTIVES

1.4.1 AIM OF THE STUDY

The aim of the study is to investigate the socio-economic characteristics of the Boteti River sub-Basin, by studying the types and patterns of water use, livelihood activities and the institutions involved in the management of water resources, with a view to determining the potential for developing integrated management of water and land resources in the sub-Basin.

1.4.2 OBJECTIVES OF THE STUDY

i. To identify and assess key livelihood activities in the sub-basin
ii. To identify and assess types and use patterns of water resources in the Boteti River sub-Basin.
iii. To examine the institutions involved in the management of water resources in the sub-Basin.
iv. To assess community participation in water resources management

1.5 THE STUDY AREA

1.5.1. GENERAL DESCRIPTION OF STUDY AREA

The study was carried out in four villages, namely Chanoga, Makalamabedi (Central) Khumaga and, Kedia of the Boteti River sub-Basin in north-central Botswana. The sub-Basin is found south of the Okavango Delta, a world renowned wetland of international importance listed under the Ramsar Convention. It is approximately 29 000km^2, an area that excludes the Makgadikgadi Pans and most parts of the inactive basin, mainly covered by fossil or currently inactive rivers (Hydrogeo (Pty) Ltd and Water Surveys (Botswana), 2001). It is part of the larger Okavango River Basin that is approximately 721 000km^2 and covers more than two thirds of Botswana's total surface area (Heyns, 1995)

The sub-Basin receives average rainfall of about 354 to 450mm per year and is highly variable (Arntzen *et al.*, 1994; Vanderpost, 1995; Hydrogeo (Pty) Ltd and Water Surveys (Botswana), 2001). The area is mainly covered by the Kalahari sands with mopane woodlands and some open grasslands, and riverine acacia (Breyer, 1983; Hydrogeo (Pty) Ltd and Water Surveys (Botswana), 2001).

The Boteti River experiences irregular spatial and temporal variations in water flow. Historical trends documented by Shaw (1985), indicate that the Boteti River used to flow perennially with intermediate short dry periods lasting only a few years except in the late 1920s to 1940s (Swatuk & Motsholapheko, 2008) (see Figure 2 below).

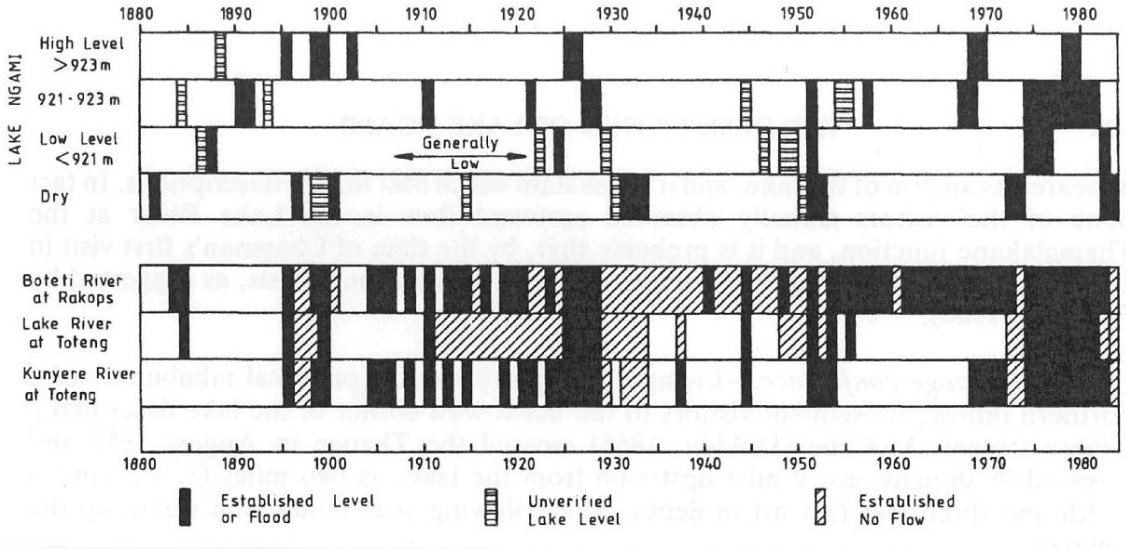

Figure 2: Lake Ngami levels and river flow 1880-1983.

Source: Shaw (1985)

Currently the Boteti is going through a long dry span receiving inadequate water flows since the early 1990s. It has a wetter or perennial upstream up to 50km from its source and a drier or ephemeral downstream spanning approximately 250km (Swatuk & Motsholapheko, 2008).

1.5.2 POPULATION

The entire Boteti River sub-Basin has a population of over 48 000 people with density of 1 person per km^2 (Central Statistics Office, 2002). Most of this population is found settled along the Boteti River and in the fringes of the larger pans within the sub-Basin. Settlements along the Boteti River date back to AD700, comprising mainly of the Kalanga, Bateti/Wayeyi, Herero, San/Basarwa and other Bantu ethnic groups (Zuffrey, 1983; Tlou, 1985; Arntzen et al., 1994). Scudder *et al.,* (1993) state that settlement origin in Ngamiland (North West District) and the Boteti sub-District dates back to "at least ten

thousand years ago" with the earliest settlers being the Khoisan who were mainly hunters and gatherers.

The sub-Basin population has experienced varying degrees of dispersal and concentration over time due to changing water availability and occurrences of droughts (Silitshena, 1982; Arntzen *et al.*, 1994; Vanderpost, 1995). Environmental challenges relating to population dispersal were, encroachment of human activities to areas never reached before, reduction in wildlife numbers and habitats, increased competition between wildlife and livestock. Those relating to population concentration were, overstocking, overgrazing, over-harvesting, and denudation of vegetation leading to wind erosion. These environmental challenges have in turn resulted in lack of opportunities, wide spread poverty and out migration (Vanderpost, 1995). Population growth in the Boteti sub-Basin, has often been linked to conflicts over resource use, that include access to grazing, wildlife-human, and among competing land use types (Scudder *et al.*, 1993). It is also noted as one of the drivers of environmental change resulting in poverty.

1.5.3 LIVELIHOODS

Several farm and non-farm economic activities are sources of livelihoods for people living in the Boteti River sub-Basin. Farm based activities include livestock farming, dryland arable farming, *molapo* or flood recession cultivation, small scale gardening, and small scale poultry production. Other nature-based activities are fishing, veld products collection, "illegal" hunting, and crafts production. Non-farm activities, in the sub-Basin are small to large scale commercial enterprises, mining, tourism, formal and informal employment, beer brewing for sale, remittances and government assistance schemes.

Several studies in this and the past two decades have revealed the existence of these livelihood sources in the sub-Basin and the larger Okavango River Basin (Breyer, 1983; Scudder *et al*., 1993; Arntzen, 1994; Vanderpost, 1995; Hydrogeo (Pty) Ltd and Water Surveys (Botswana), 2001; Scott Wilson Kirkpatrick and Partners & Ecosurv (Ltd), 2002; Swatuk & Motsholapheko, 2008).

Households in the sub-Basin, and the wider Okavango River Basin, practice these economic activities in a diversified production system, to reduce risk in an unstable or harsh environment (Scudder *et al.,* 1993; Vanderpost, 1995; Wilk & Kgathi, 2007). Most livelihoods, particularly farming or nature-based ones are dependent on availability of water either within the river itself or in underground aquifers away from the river. Due to availability of low saline groundwater mostly attainable through shallow wells and the gradually increasing salinity of water away from the river most livelihood activities are undertaken near the river (Hydrogeo (Pty) Ltd and Water Surveys (Botswana), 2001). The drying of wells, prolonged drying of the Boteti River, human and animal diseases, inappropriate management and commercialization of resource exploitation have also been noted (Arntzen *et al.*, 1994; Vanderpost, 1995; Darkoh, 1997).

1.5.4 INSTITUTIONS

The Boteti sub-District is administered from the sub-district capital of Letlhakane. District level institutions available in the sub-district are the District Administration (DA), Tribal Administration and the District Council, administered by the Ministry of Local Government, and the Tribal Land Board administered by the Ministry of Lands and Housing.

The DA is the main coordinative and administrative body for all sectoral ministry departments. It also performs judicial functions (SMEC, 1991; Arntzen *et al.*, 1994). The District Commissioner (DC), who heads this body, chairs the District Development Plan Committee which does all planning for development and provision of social services in the sub-district. The DC is the most senior representative of central government and does judicial functions both for common law and customary law. The DC also coordinates all development projects in the sub-district and as such plays critical role in their planning and implementation. This makes this institution critical in the development of plans as well as policy implementation, which has a bearing on water management. Figure 3 below illustrates the structure of district level institutions.

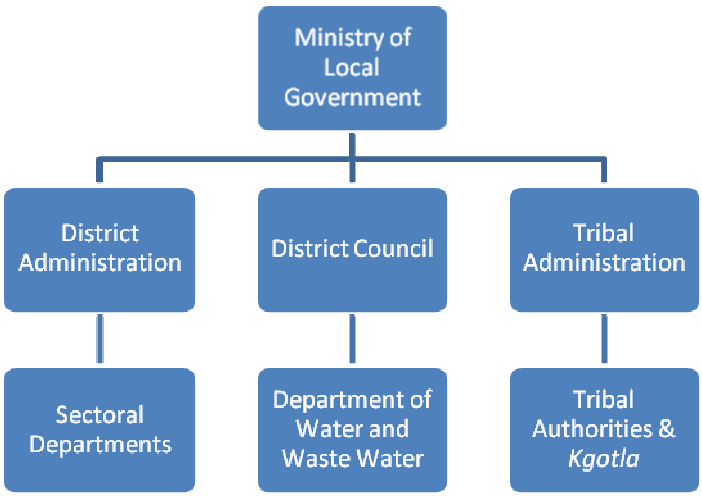

Figure 3: Structure of some district level institutions

Tribal Administration comprises the paramount chief, chief's representatives and headmen. It is the administrative and judicial guardian of tradition and custom at the community level. It is based at the *kgotla,* customary court or the place and forum for discussing community issues (SMEC, 1991; Arntzen *et al.*, 1994; Kgathi *et al.*, 2004).

Before the enactment of the Tribal Land Act (TLA) of 1970, water, land and related resources were controlled by paramount chiefs who had authority in tribal territories while the district commissioner held authority over the then crown land districts (Schapera, 1970). The chiefs administered the allocation of land through a system of land overseers, mostly men with profound knowledge of past and present land use in their areas (Kgathi *et al.*, 2004). Currently, tribal administration does not allocate land nor does it have any significant control over the use of other natural resources, including water. All powers, relating to natural resources management, have been usurped to various sectoral departments of the national government, through enactment of several laws (Clayton, 1995; Bose, 2002; Kgathi *et al.*, 2004). However, this institution can and still plays a pivotal role in information dissemination, awareness creation and at times acts as advocacy platform for environmental protection (Kgathi *et al.*, 2004).

The District Council is responsible for the provision of social services, local infrastructure as well as licensing of local commercial entities, and has both direct and indirect bearing on the management of water and other natural resources (SMEC, 1991; Arntzen *et al.*, 1994). "Their potable water supply projects…[may] indirectly affect spatial distribution of population, hence human pressure on environmental resources" (Arntzen *et al.*, 1994, p.54). The district council Department of Water and Waste Water, supplies water to all rural settlements, of population not less than 500 people, or those recognized as settlements under the National Settlement Policy (Ministry of Local Government Lands and Housing, 1998).

The Tribal Land Board is the sole authority in the administration and management of land in communal areas (Arntzen *et al.*, 1994). It is made up of members elected by the

community as well as those nominated by the Minister of Lands. This institution has a bearing on the management of water and other resources since it issues land rights for various activities including allocation of land for boreholes, dams, wells and other land uses (SMEC, 1991; Rahm *et al.*, 2006). In a move seemingly aim at correcting the ills of taking land allocation from traditional leaders, this institution now uses the system of land overseers elected by the community members at the *Kgotla*. It may serve useful purpose in community participation

Village level institutions include the *kgotla*, village wards, village development committees, village health committees, local NGOs, women's and youth groups. In a study of local institutions in Mopipi, Xhumo and Kedia villages, Zuffrey (1993) differentiates village institutions into two main types being the modern and traditional ones. Traditional institutions are the *kgotla*, family wards and council wards, while modern institutions are development oriented such as village development committees (VDCs), farmers committees, village health committees (VHCs), youth committees and other social welfare committees. Studies indicate that all the main villages in the study area have both traditional and modern institutions (Zuffrey, 1983; Arntzen *et al.*, 1994; Clayton, 1995; Hydrogeo (Pty) Ltd and Water Surveys (Botswana), 2001). In theory, for purposes of natural resources management, there are supposed to be Agricultural Resources Conservation Committees in all villages in Botswana (Kgathi *et al.*, 2004). However, the available literature does not point to the presence of such committees in the study area.

As indicated earlier, water in Botswana and the Boteti sub-Basin, is managed centrally by the government. The Ministry of Minerals, Energy and Water Resources (MMEWR) is

responsible for national water policy with some level of decentralization to other state organs (SMEC, 1991; Swatuk & Rahm, 2004; Rahm *et al.*, 2006; Swatuk & Kgomotso, 2007). In urban areas, the Water Utilities Corporation is responsible for supplying water to all cities and towns, in addition to the country's mines. In the rural areas, water is supplied and managed by the Department of Water Affairs (DWA) and the respective district councils depending on settlement size. Apart from the main water management structures as shown in Figure 4 below, there are water management units in other sectoral departments such as agriculture, fisheries, tourism, wildlife, health, works, transport and communication.

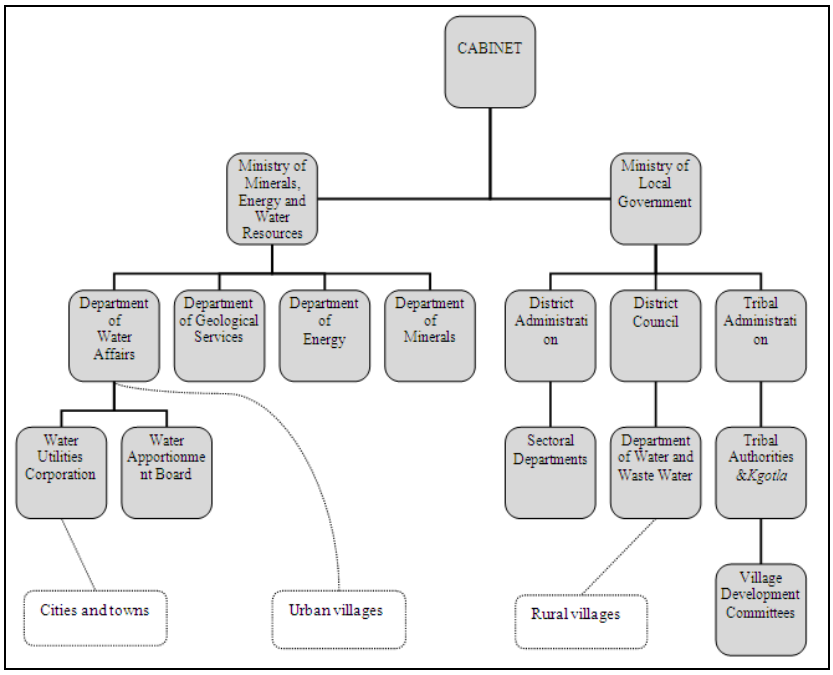

Figure 4: Structure of water management institutions in Botswana.
Source: Compiled from SMEC (1991)

While the major water roles of the Department of Water Affairs and district council[1] are water resources development, supply, maintenance and application of water regulations

[1] District council also develops water sources, in remote settlements (North West District Council, 1995)

the different sectoral units and departments that fall under various ministries also implement their own policies, and play their own roles some of which are competitive and may contrast with those of the main water management institutions (Swatuk & Rahm, 2004; Rahm *et al.*, 2006; Swatuk & Kgomotso, 2007).

This chapter has provided an overview of the research problem, the rationale for the study, stated the working hypothesis and objectives and provided a wide insight of the study area. The next chapter details the theoretical frame work for the study, discussing origins and development of integrated water resources management (IWRM). It also highlights on other studies conducted in the Boteti River sub-Basin.

CHAPTER 2: LITERATURE REVIEW

2.1 THEORETICAL BACKGROUND

The theoretical background of this study anchors around integrated water resources management (IWRM), defined as; "... a process which 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" (Global Water Partnership, 2000). The approach emphasizes the coordinated management of water and land based on an "*enabling environment* of suitable policies, strategies and legislation"; *"institutional framework*….to put the policies, strategies and legislation into practice" and "*management instruments* required by these institutions to do their job" (Global Water Partnership, 2006, p.59). IWRM derives its logic from systems science and benefits from global endorsement in sustainable development programmes (Newson, 2004). However, it also finds its place in socio-economic, political and cultural sciences since it links development and management of water with maintaining the integrity of ecosystems through participatory processes (Allan, 2003; Newson, 2004).

Early attempts at implementing the integrated water resources management can be traced back to the 1930s in the rational comprehensive planning that aimed at integrating flood control, pollution control, water supply and conservation in the United States (Mukhtarov, 2008). However these failed mainly due to their focus on developing comprehensive plans which were more centralized, expert driven and "..against the "democratic" means of decision-making through lobbying and the struggle of different

organized interests..” (Mukhtarov, 2008, p171). Efforts aimed at river basin management and planning started in Canada in the 1940s with the establishment of the Ontario Conservation Authorities which served as river basin management organizations (Mitchell, 2006). Though such initiatives were not known as IWRM, they promoted some of the main principles underpinning this approach. Local initiative, comprehensive perspective, coordination and cooperation were pursued and the river basin was considered as a management unit (Mitchell, 2006). This was a shift from centrally managed, top-down approach to more consultative and locally-driven management.

IWRM in its current form has been initiated and promoted firstly by the UN since the 1950s and now widely embraced by various international, regional organizations and national governments, throughout the world as a tool that can enhance proper management of water and land resources (Serageldin, 2000; World Bank, 2004; Global Water Partnership, 2006; Mukhtarov, 2008).

According to the *Ecological Principle*, one of the Dublin set of water management principles, the river basin is the centre of focus for improving the management of water and related terrestrial resources (Solanes & Gonzales, 1999; Serageldin, 2000). River basins, defined by their watersheds, surface and ground water resources as well as terrestrial and aquatic resources are critical reference points as they are the main source of fresh water. They are therefore accepted as spatial units for implementing IWRM (World Bank, 2004; Global Water Partnership, 2006).

For ephemeral river basins, in southern Africa, implementing IWRM has the potential for striking a balance between availability of water and land resources and maintaining the

integrity of the ecosystems. The approach emphasizes more stakeholder participation and development of environmental solutions that are locally-based. Such a bottom-up approach can facilitate the transformation of water management institutions such that operational rules for users are made and internalised locally as "rules in use" and not imposed from elsewhere (Ostrom, 1992). Ephemeral rivers are sensitive areas in that they often serve as nerve centres or "linear oases" within arid zones (Turton *et al.*, 2003). This makes them centres of attraction for various livelihood activities. High activity in the use of water and land resources often results in increased competition and conflicts, which often result in denudation of vegetation, general degradation and ultimate decline in livelihoods (Arntzen *et al.*, 1994; Vanderpost, 1995; Hydrogeo (Pty) Ltd and Water Surveys (Botswana), 2001; Scott Wilson Kirkpatrick and Partners & Ecosurv (Ltd), 2002).

2.2 APPLICATION OF IWRM IN SOUTHERN AFRICA

IWRM approach is steadily developing in the southern African region. SADC Member States began their commitment to coordinated and integrated management of water resources by formulating, agreeing and for some countries ratifying the SADC Protocol on Shared Watercourse Systems which aims to ensure equitable sharing of water as well as its efficient conservation as a scarce resource (Southern African Development Community [SADC], 2000; Southern African Development Community [SADC], 2002). The formulation of the SADC Protocol came as an urgent response to fears about declining water quality and quantity in the face of growing population and increased water demand for various purposes. The Protocol endorses the formation of river basin management systems (SADC, 2000; SADC, 2002). Countries of the region have thence seen a need to form various river basin agreements to enhance cooperation among them

in order to avoid possible conflicts that may result from varying interests over the use of river water. At the international level, such agreements form the basis for common understanding and provide a conducive environment for subsequent harmonization of national policies relating to water governance across national boundaries.

Since the mid-1990s countries in the region have engaged in consultations that resulted in increased awareness on the importance of regionally coordinated water management (SADC, 2006). A regional water sector was established within the SADC Secretariat and a Regional Water Strategy and Action Plan was then developed using the IWRM approach (Arntzen & Kgathi, 2005; Southern African Development Community Water Sector Coordinating Unit [SADC-WSCU], 1999). The SADC Water Policy principles are largely guided, among others, by the Dublin Principles of water management (SADC, 2006). At the World Summit on Sustainable Development (WSSD) held in Johannesburg in 2002 all countries, including those in the southern African region agreed to the formulation of national IWRM plans by 2005 (World Summit on Sustainable Development[WSSD], 2002, p.22).

Regional efforts to develop river basin management systems have already taken off in some countries in southern Africa. Countries worth noting include Zimbabwe, Namibia, South Africa and to some extent Zambia and Botswana. The aim for such efforts is to develop best approaches in the sustainable management of natural resources in river basins. These take the form of: water point and river basin committees in Namibia; catchment and sub-catchment councils in Zimbabwe and positive efforts to enrol community participation in the R-WASHE (Rural Water Supply Sanitation Health Education Committee) and V-WASHE (Rural Water Supply Sanitation Health Education

Committee) in Zambia (Dube & Swatuk, 2002; Kampata *et al.*, 2002; Botes *et al*., 2003; Manning & Seely, 2005).

Namibia, viewed by some as the "driest" country in the southern African region is quite advanced in the development of the forum for integrated resource management (FIRM) approach (Manning & Seely, 2005). Stemming from government willingness to devolve natural resources management to local communities, the FIRM concept ushers in a new dimension in the way water and land resources, particularly in ephemeral rivers, are managed (Botes *et al.*, 2003). Of greatest interest is the environmental learning and action in the Kuiseb (Elak) project, which focuses on facilitating common understanding and cooperative action, learning and decision making among stakeholders in the management of the ephemeral Kuiseb River in west-central Namibia (Botes *et al.*, 2003). Through this project the Kuiseb Basin Management Committee has been formed where all stakeholders, grouped together to form one community of similar interest, sharing an area and its resources and a common goal, came together for a common vision of a "healthy Kuiseb River", meaning sustainably providing for livelihoods as well as maintaining ecological integrity (Botes *et al.*, 2003). Briefly described this puts "the community in the driver's seat for addressing particular resource management needs" (Manning & Seely, 2005, p.890).

Implementation of IWRM faces numerous institutional and capacity challenges in most developing countries (Arntzen, 2003; Allan, 2003; Biswas, 2004; Van der Zaag, 2005; Merrey, 2008). This has led to new line of thinking relating to its conceptual and definitional standing, being mainly useful as a framework for educating professionals and lay persons without clear focus on improvement of livelihoods of the poor (Merrey *et al.*,

2005; Merrey, 2008). The main point is that, for developing countries IWRM implementation needs to focus on improving livelihoods within the broader area of integrated natural resources management. Magole (2008) also posits that even adopting IWRM does not guarantee implementation which depends among others on the interpretation of the approach and the socio-political and cultural environment. So far only three southern African countries (Zimbabwe, Namibia and South Africa) have reached high level of planning to achieve IWRM. Botswana is one of those countries that are still in the process of preparing national plans and strategies with further work required to implement IWRM (Global Water Partnership, 2006).

2.3 APPLICATION OF IWRM IN BOTSWANA AND THE STUDY AREA

Botswana is among countries that made commitments at the WSSD to develop IWRM plans by 2005. Following on this commitment, the country has now finalized the review of the National Water Master Plan of 1991 with a view to aligning it to the IWRM approach. Efforts to conserve and sustainably manage water resources have been resounded at various levels with government making commitments to provide clean drinking water to all citizens as well as avail highly needed water for various uses in all sectors of the economy (Ministry of Finance and Development Planning [MFDP], 2003; Global Water Partnership, 2006). Wise use of water resources and demand management are key issues being considered for action in the National Development Plan 9 (MFDP, 2003).

Consultation among stakeholders and their inclusion in water planning process has commenced and efforts are being made to embed IWRM in ongoing programmes and activities, good examples being the ODMP (Okavango Delta Management Plan) and the

review of the National Water Master Plan (Global Water Partnership, 2006). The development of the ODMP through direct stakeholder participation marked a new era in Botswana's planning history. The process was coordinated by the newly established Department of Environmental Affairs (DEA) and it brought together all government departments charged with planning, development and service delivery in the entire North West District. The process was issue driven as it was guided by issues raised by stakeholders mainly relating to general management failure and the inherent contradictions in uncoordinated sectoral planning and service delivery (Magole, 2008). The development of this plan could be used as a bench mark for future IWRM implementation and general sectoral and institutional reform to link research with capacity development, improve service delivery and promote coordinated planning (Swatuk & Kgomotso, 2007).

Great strides have also been made, through non-governmental organization (NGO) initiatives in the Every River Has Its People project. The project culminated in the formation of a basin-wide forum, made up of representatives of all communities, contributing to decision making for the management of Okavango River Basin resources. Though this initiative is not explicit about water, the issues revolve around water as a key resource and the involvement of communities in water and land resources is key to IWRM principles (Global Water Partnership, 2006). These initiatives have shown the general willingness of communities, and other stakeholders, to participate in decision making and planning. ODMP covers areas within the Okavango Ramsar site, Samedupe to Makalamabedi (North West) [2] in the study area, and some representatives in the

[2] A district boundary between North West and the Central districts splits the village of Makalamabedi into two villages administered differently by the two districts.

Basin-wide Forum come from some villages in the study area such as Chanoga and Makalamabedi (shown in Figure 1).

There are several pieces of legislation in Botswana that support the protection of water resources as well as the wise use of water, though without direct reference to IWRM or its implementation. These are the Water Act (1968), Waterworks Act (1962), Waterworks Amendment Act (1983), Borehole Act (1956), Water Utilities Corporation Act (1970), and Water Utilities Corporation Amendment Act (1978). Water remains the State's domain and its control is delegated to various state organizations (Swatuk & Rahm, 2004; Swatuk & Kgomotso, 2007). This implies that the key users of water resources still do not have direct role in key decision-making on water. IWRM requires that communities be directly involved in the planning process. Indications from literature are that the implementation of IWRM especially in the Boteti River sub-Basin is still to be contemplated.

The review of the main policy document the Botswana National Water Master Plan has just been completed and its implementation in reviewed form is not expected shortly. With the current centralized, sectoral and generally fragmented water management practices still so rigid to change, the Boteti River sub-Basin is still a long way to implementing integrated water resources management let alone most other areas in Botswana. Water management is still supply driven with the main water suppliers, Department of Water Affairs and the district council, still pre-occupied with securing new supply sources and working to overcome general water shortages (Swatuk & Kgomotso, 2007). Water supply is faced with the challenges of financial shortages, lack of skilled manpower, poor maintenance, over-exploitation of available groundwater, poor

monitoring and most of all absence of regulative mechanisms for water development among sectors (Swatuk & Kgomotso, 2007)

As indicated earlier, water management in Botswana is still centralised. Some level of decentralisation from central to local government has occurred in rural and remote areas, without, integration among sectors, local participation in decision making and there is no effective subsidiary. This has variously been revealed by several studies in the water sector (Swatuk & Rahm, 2004; Rahm et al., 2006; Swatuk & Kgomotso, 2007; Magole, 2008; Swatuk & Motsholapheko, 2008). Swatuk & Kgomotso (2007) have shown that government devises and implements policies without listening to communities. Magole (2008) has also shown that there is general power imbalance between communities and government leading to unilateral decision making in favour of government.

2.4 OTHER STUDIES UNDERTAKEN IN THE BOTETI RIVER SUB-BASIN

Several water related studies have been carried out in the Boteti River sub-Basin (SMEC, 1991; Arntzen *et al*., 1994; Vanderpost, 1995; Hydrogeo (Pty) Ltd and Water Surveys (Botswana), 2001; Scott Wilson Kirkpatrick and Partners & Ecosurv (Ltd), 2002; Brooks, 2003; Leutlwetse, 2006; Sadoff, 2006; Matsapa, 2007; Sam, 2007; Ecosurv, 2008). In a comprehensive study of the mid-Boteti area, Arntzen *et al.* (1994) investigated various aspects of desertification and possible mitigation and adaptation strategies. The study covered numerous aspects of resource management and uncovered the many challenges facing the inhabitants of the Boteti River sub-Basin. This research was more applied research with emphasis on identifying the challenges and suggesting solutions. Vanderpost (1995) also identified environmental challenges resulting from population pressure, highlighting some management practices that exacerbate environmental

degradation. Both studies addressed environmental challenges with implications for water management without direct reference to application of integrated water resources management or river basin management as one of the solutions to the challenges in the Boteti River sub-Basin.

Another comprehensive investigation into water management is the National Water Master Plan conducted by SMEC (1991). This was a national study with less specificity on regional or basin level water management. However water management institutions and general socio-economic, cultural, and environmental conditions referred to in this study are relevant to most parts of Botswana. Most other studies focused on specific areas of resource management in various sectors. Livelihoods and water use patterns and their relation to community participation have not received focused attention in these studies.

This chapter has provided the theoretical basis for the study and has revealed that integrated water resources management approach has been developing throughout the world. It has been shown that the development of this approach necessitates that many countries, including Botswana, review their water management practices in order to adopt and adapt best practices observed in other countries. Some of the environmental challenges such as the ones noted in Chapter 1 may be linked to current planning or water management practices as suggested in Hypothesis 1. So an investigation of all aspects of water management, such as water use types and patterns, the institutions involved, human activities and linkages with the bio-physical conditions, may be necessary. The next chapter presents the methodology for this study. It describes the approach and methods used in the selection and investigation of the study units (households) in order to meet the objectives stated in Chapter 1.

CHAPTER 3: METHODOLOGY

3.1 INTRODUCTION

The study was carried out through a multi-method approach employing both desk top and field approaches. Desktop approach involved data searches from secondary sources such as government and other published reports, books, journals, anecdotes, existing databases and internet searches. The key strength of desktop approach is that it is cost effective and can provide useful data within reasonable collection time. A lot of data on population size, livestock numbers, water consumption, available institutions, and land use maps were collected using this method. However, the method has the limitation of being too rigid in form such that data manipulation is difficult or just not possible at times and will not necessarily serve the interest of the researcher (McNamara, 1999).

Field data collection entailed the use of surveys, focus groups, field observations, interviews, open discussions with respondents and key informants. These have the strength in being more original and providing up-to-date information (McNamara, 1999). Data obtained can easily be manipulated to follow the general line focus of the study. These methods have the limitation of being expensive and time consuming compared to desktop studies. Desktop approaches often produce secondary data while field approaches produce mainly primary data and when both methods are used the study can benefit from their strengths.

The next sections describe the methodology under the sub-headings sample design, sample selection, data collection and data analysis. The last section describes the pilot study that was carried out before the main study to test the methods described in the aforementioned sections.

3.2 SAMPLE DESIGN

For purposes of final selection of the sample in the study area, the concepts of theoretical population, accessible population and selected sample were used. A theoretical population refers to "...all participants of the theoretical interest to the researcher and to which he or she would like to generalize"; accessible population is the sample frame or the population from which a sample will be drawn; and selected sample refers to a group of participants selected from the accessible population (Gliner & Morgan, 2000). In this study the entire population of the Boteti River sub-Basin is the theoretical population. The accessible population was made up of four villages selected among the sub-Basin settlements based on geographical location and settlement categorization under the National Settlement Policy (as explained in the next subsections). Few villages had to be selected for study to provide a manageable and representative sample of the area.

3.2.1 GEOGRAPHICAL LOCATION

In order to select the villages for this study, geographical location in the sub-Basin was considered. This was meant to obtain a geographically representative sample of villages in the sub-Basin. The entire study area as shown in Figure 5 below was represented by the settlements from Samedupe on the upstream- to Mokoboxane on the downstream-part of the Boteti River.

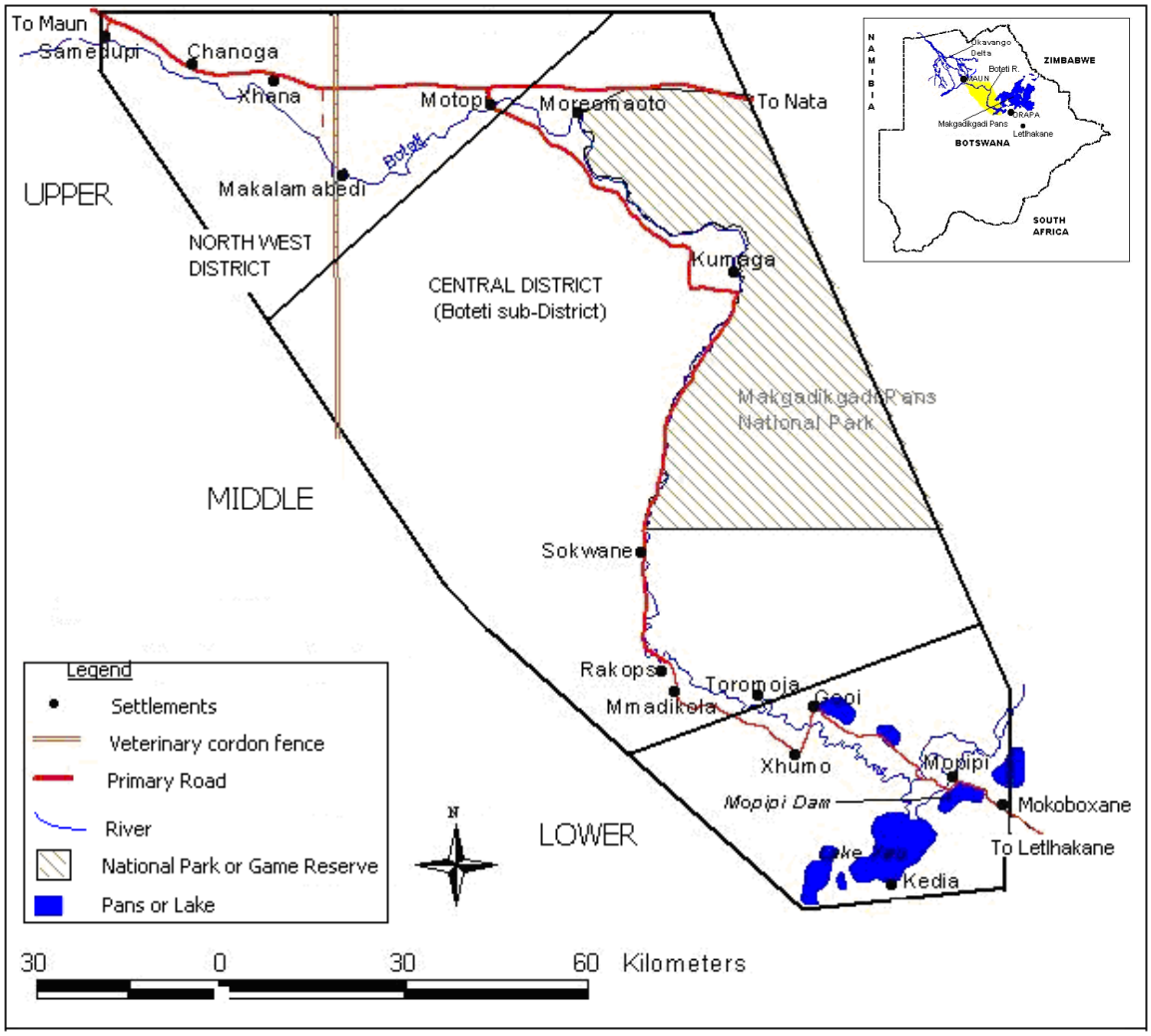

Figure 5: Map of the study area showing the three blocks of the upper, middle and lower Boteti River sub-Basin

Source: Adapted from HOORC (2006)

The study area was divided into three blocks representing the upper, the middle and the lower Boteti River. Determination of the blocks was guided mainly by the differences in physical location along the river and the currently prevailing physical conditions. The upper Boteti was represented by the villages of Samedupe, Chanoga, Makalamabedi (Central), Makalamabedi (North West) and Motopi. This is the area that currently receives flood water from the Okavango Delta and therefore generally wet or perennial.

The mid-Boteti was represented by Moreomaoto, Khumaga, Rakops, Mmadikola and Toromoja. This is the area in transition and closer to the wetter upstream. The lower Boteti was represented by Mopipi, Mokoboxane, Kedia and Xhumu. This area has not received any flood water since 1991. It is therefore the driest part of the Boteti River sub-Basin.

3.2.2 SETTLEMENT CATEGORISATION

In order to obtain a selection of villages that was representative of the entire study area in terms of demographic profile, socio-economic activities and water supply facilities available, the National Settlement Policy guidelines for categorization of settlements were used. The main assumption was that settlements provided with similar infrastructure and level of sectoral services, have similar organizational structure for services provision with similar implications for the management of natural resources. It was assumed that once a settlement in a certain category is selected; it represents other settlements in the same category.

The National Settlement Policy classifies settlements into primary, secondary and tertiary categories depending on population size, services provided and available infrastructure. Tertiary settlements are further classified into four categories of Tertiary I, II, III and IV of population size 5000 to 9999, 1000 to 4999, 500 to 999 and 250 to 499 respectively (Ministry of Local Government Lands and Housing [MLGLH], 1998).

There are 16 villages and numerous associated localities[3] or small settlements in the study area with the estimated population of 25,872 people (Central Statistics Office, 2002). According to National Settlement Policy, all these are tertiary settlements. Table 1 below shows village categories by population size.

Table 1: Villages of the Boteti River sub-Basin categorized according to population size

Category	**Village**	**Population size**
Tertiary II (1000 - 4999 people)	Makalamabedi (Central District)	1117
	Motopi	1130
	Tsienyane/Rakops	4555
	Xhumo	1591
	Mopipi	3066
	Mokoboxane	1290
Tertiary III (500 - 999 people)	Moreomaoto	526
	Khumaga	925
	Mmadikola	828
	Toromoja	649
	Kedia	793
Tertiary IV (250 - 499 people)	Chanoga	381
	Makalamabedi (North West District)	344
	*Associated localities	9794
Total		**25 872**

Source: Compiled from Central Statistics Office (2002).

As shown in Table 1 above the first set of villages are Tertiary II settlements, the next set are Tertiary III and the last two villages are Tertiary IV settlements. The fourth category is made up of associated localities of arable lands and cattle posts. The small villages of Samedupe, Xhana and Gope are un-gazetted settlements which do not fall in the first three categories and have been included under associated localities.

[3] Central Statistics Office classifies all small, mostly un-gazetted, settlements of lands and cattle-posts surrounding main villages under the category “Associated localities”.

3.3 SAMPLE SELECTION

The four villages of Chanoga, Makalamabedi (Central), Khumaga and Kedia were considered to make up the accessible population for this study. Chanoga was considered, as a Tertiary IV (250-499 people) settlement, located within the upper- or wetter part of the Boteti. Makalamabedi (Central) is a larger village considered for this study as a Tertiary II (1000-4999 people) settlement located in the upper Boteti on the border line between the Central and North West Districts. Khumaga is a Tertiary III (500-999 people) settlement, bordering the Makgadikgadi National Park and had the advantage of providing insight into wildlife human conflicts. Kedia was selected since it is located in the lower Boteti on the edge of the now dry Lake Xau. It was meant to provide insight into issues relating to losses of large standing water bodies resulting from the prolonged drying of the lake. It also adds another dimension as a remote area development[4] (RAD) settlement. The villages of Rakops and Mopipi could not be included in the sample since they are part of simultaneously ongoing study under the Desertification Mitigation and Remediation of Land (DESIRE) project and this study stands to benefit from the findings thereof. These two villages are Tertiary II settlements that provide administrative and to some extent commercial services to the surrounding smaller villages.

In order to obtain the number of households to be sampled in the four villages, the population size in each village and the national average rural household size of 4.4 were used. A sample of 40% or 293 households from a total number of 731 households was selected from the four villages. The sample represents a population of 1285 people or 5%

[4] Remote area development settlements are villages that in most cases do not meet the National Settlement Policy threshold of 500 people, but designated as villages under the Rural Area Development Programme (RADP) that seeks to avail services to specially disadvantaged rural area dweller communities, mostly San people.

of the theoretical population. The number of households per village was calculated such that it is proportional to population size in each village. Table 2 below shows the population size, total number of households and the number of sampled households in the selected villages.

Table 2: Population size, total number of households and the number of sampled households in the selected villages

Village	Population size	Total number of households	Number of sampled households
Makalamabedi (Central District)	1117	254	102
Khumaga	925	210	84
Kedia	793	180	72
Chanoga	381	87	35
Total	3216	731	293

Source: Compiled from 2001 National Population and Housing Census (Central Statistics Office, 2002)

Sample size estimations vary from one study to another depending on availability of resources including time required to undertake research. Balnaves & Caputi (2001, p94) recommend sample sizes of 30 units or more, noting that "there are few occasions in behavioural research where samples smaller than 30 or larger than 500….can be justified". Moser & Kalton (1971) note that a sample of not less than 5% represents a relatively high proportion of the total population. Given the limited financial and time constraints it became necessary that a more affordable, manageable and statistically representative sample be selected.

Enumeration area (EA) maps from the Central Statistic Office were used to provide a sampling frame, in the villages of Khumaga and Makalamabedi (Central). Details on the

maps were verified and updated for new developments that came after the 2001 National Population and Housing Census. Since the household lists were not available, household listing was done to ensure accuracy. A total of 288 and 295 households were listed in villages of Khumaga and Makalamabedi respectively.

The EA map for the village of Chanoga had several inaccuracies that made it unusable while that for the village of Kedia was not available from Central Statistics Office. In these villages direct mapping and listing of households were done for 77 and 202 households in Chanoga and Kedia, respectively. Before the study was carried out a pilot survey was undertaken to test the methods of sample selection, acclimatise the enumerators to field conditions and to test the data collection instrument.

In the final stage of selection of households the systematic sampling method was used. In this method, the first household was selected using a table of random numbers. Subsequent *n*th households from the first household were systematically selected in each of the four villages. A total of 293 households were selected for the sample.

3.4 DATA COLLECTION

A questionnaire with a set of both open- and closed-ended questions was directly administered to the selected households in the villages. The questionnaire had sections that were arranged to suit the set objectives of the study and gathered household data on; demographic background, types of livelihood activities, types and patterns of water use and water management institutions. A team of 3 well trained enumerators was mobilized for data collection and spent 4 weeks in mid-February to March 2008 collecting the data.

In addition to the questionnaires administered to households, key informant interviews were conducted with 6 village leaders and 5 local government officers. More focused open-ended questions were used to collect in-depth information on village level institutional dynamics. Informal discussions were also held with 3 local farmers. A focus group discussion was conducted among 12 community representatives of the ERB-SADC project. This was meant to obtain village specific environmental issues relevant to water management. These representatives were easier to reach during the environmental awareness tour of the Okavango Delta pan-handle undertaken on 12th to 15th February, 2008. Both informal interviews and focus group discussions were useful in the collection of qualitative data generated from free expressions of opinion.

3.5 DATA ANALYSIS

All primary data collected using the household questionnaire were coded, entered, cleaned for errors and prepared for final analysis. Coding, involved allocation of numerical identifiers for questionnaire responses given by households. It was done for closed-ended and some codable open-ended responses. Cleaning was done both manually (directly on the questionnaires) and electronically (in the entered data), to verify recorded responses and correct errors resulting from data entry, respectively. Electronic data cleaning involved running a preliminary analysis of frequencies and then correcting errors by verifying against responses in the questionnaires. A final analysis was done using frequency distribution, measures of central tendency, chi-square and correlations. This was because most of the data collected were made up of measurable numerical variables. The results are presented in chapter 4.

3.6 THE PILOT STUDY

A pilot study was carried out during the first week of December 2007 the aim of which was to test the methods suggested for the main study. The idea was to establish whether the use of enumeration area (EA) maps and/or ordinary household listing will be appropriate for the main study as well as to test the study questionnaire in real field conditions.

EA maps for Makalamabedi (Central) and Khumaga were used to select households for the pilot study. One enumeration area was selected in each village and household listing done in these EAs. Ten households from each village were then selected by systematic sampling where a table of random numbers was used to select the first household and the rest followed systematically.

In Chanoga the EA map was found to be inconvenient to use since it did not accurately show the village location. The position of the village was wrongly placed and village features not clearly represented on the map. In Kedia the EA map could not be obtained from the Central Statistics Office. Therefore in these two villages a different method had to be used instead of EA maps.

In Kedia, one ward was selected and the position of the main water tower was used as a reference point. Mapping and listing of all households in the ward was done and the first household was selected using the random number table. The rest of the households were selected systematically. In Chanoga the same procedure was used with the village *Kgotla* used as a reference point. Ten households were selected in each of these villages.

A total sample of 40 households was selected for the pilot survey and a questionnaire with closed- and open-ended questions was administered to all the selected households. Closed-ended questions were used mainly for variables with predictable attributes such as "gender" and "marital status". These variables are predictable in that their responses can be pre-determined or formulated since they are clearly defined. For those variables that cannot be exhaustively predetermined, options for additional or unpredictable responses or attributes were catered for under the category "other specify". In this case, the respondent would be required to specify or state the rare or unpredictable response or attribute.

The other set of variables was created using open-ended questions, which are usually used in social research to capture free expression of opinion. They were used, in this study, to stimulate discussion and help gather in-depth understanding of some responses. They provided the benefit of tapping from the respondents' knowledge about certain issues. The questionnaire was made up of four sections of demographic information, types of livelihood activities, types and patterns of water use and management institutions. In this pilot survey, 2 well trained enumerators were engaged in the household listing, EA map confirmation, mapping and the administering of the questionnaire.

3.6.1 RESULTS OF THE PILOT STUDY

The selection of households using EA maps was difficult in that the household identifiers as pinned in the 2001 National Population and Housing Census were difficult to locate. Some were found missing from where they were placed, being moved or lost when doors

were replaced. However, the listing of households provided useful information for the selection of households to be interviewed. With slight updating the maps provided enough information for the villages of Khumaga and Makalamabedi (Central District). Sample selection was easier with clear trace back in case of need for recall.

In the two villages of Kedia and Chanoga direct mapping and listing of households provided enough information required for sample selection. It was also easier to locate the households mapped. However, mapping and listing proved to be time consuming given limited time, insufficient financial and human resources and the urge to minimize the cost of the pilot survey.

Since the pilot was carried out at the end of the year during the ploughing season timing was another factor that had some impact. For the villages of Chanoga, Makalamabedi (Central) and Khumaga, most residences had no one available to provide details required for listing, particularly the names of household heads. In some cases household members were away in the morning to late afternoon making it difficult to complete the listing exercise on time. The method of selection of households was the same and with the proportionate sample size, data collected showed to be reasonably representative of the study area.

Following the pilot it was decided that direct mapping and household listing be done in Kedia and Chanoga. In Makalamabedi (Central) and Khumaga the maps were reasonably accurate and only household listing could be done. It was also decided that systematic sampling be used in all the villages since the maps obtained from direct mapping and the Central Statistics Office made it possible to locate the households.

This chapter described the methods used in the design and selection of the sample, and the collection and analysis of data. The next chapter presents the results of the study with a view to meeting the stated objectives and testing the working hypotheses.

CHAPTER 4: RESULTS AND DISCUSSION

4.1 INTRODUCTION

The main survey was carried out in mid-February to mid-March 2008. The methods of sample selection and data collection were as detailed in Chapter 3, with a total sample of 293 households from the villages of Chanoga (35), Makalamabedi (Central) 102, Khumaga (84) and Kedia (72). These households represent a total population of 1863 people. The total population was obtained from the household schedule that listed all members within a household. The schedule obtained details on gender, age, marital status, highest education attained, ethnicity, religion, relationship to head of household, whether employed and their occupation.

The following sections present the results and discussion of the main survey under the sub-headings; household demographic characteristics, types of livelihood activities, types and patterns of water use, and water management institutions. “Household demographic background” is an insight into the general household dynamics useful for explaining natural resources use and livelihoods. Data on education, age and gender can help explain the capacity of communities to manage resources as stated in the working hypothesis 2. “Types of livelihood activities” addresses objective i) and helps test hypothesis 1. An assessment of types of livelihoods found in the river basin can help identify community stakeholders to be involved in river basin management. “Types and patterns of water use” addresses objective ii); and “Water management institutions” addresses objective iii) and iv), it also helps assess the willingness of communities to manage resources as stated in hypothesis 2.

4.2 HOUSEHOLD DEMOGRAPHIC CHARACTERISTICS

Household demographic and socio-economic characteristics are important for river basin management since they reveal the key element in natural resource use being the overall dynamic of the human population. They provide information, on household composition and structure, which may help explain population growth/decline as well as possible rise/decline in demand for resources. The main demographic indicators used were age, sex/gender, marital status, highest education attained, ethnicity, type of household (whether *de jure* or *de facto,* see sub-section 4.2.2), household size and religion. The socio-economic indicators were occupation, employment status, type of housing structure, and type of energy source for lighting, heating and cooking.

4.2.1 HOUSEHOLD AGE DISTRIBUTION

Data on the age/sex distribution were collected for all members of selected households in the study villages. The results indicate that the selected villages of Chanoga, Makalamabedi (Central), Khumaga and Kedia are dominated by a young population in the age groups 0-4 years to 25-29 years with the general distribution of the population narrowing down in the upper age groups. This is also the case at the sub-District and national levels where a higher proportion of the population (49.3%) is concentrated in the lower age groups 0-4 years to 20-29 years (Central Statistics Office, 2004). As shown in Figure 6 below, women make up the majority of the population accounting for a comparatively higher percentage of the total population in almost all the age groups.

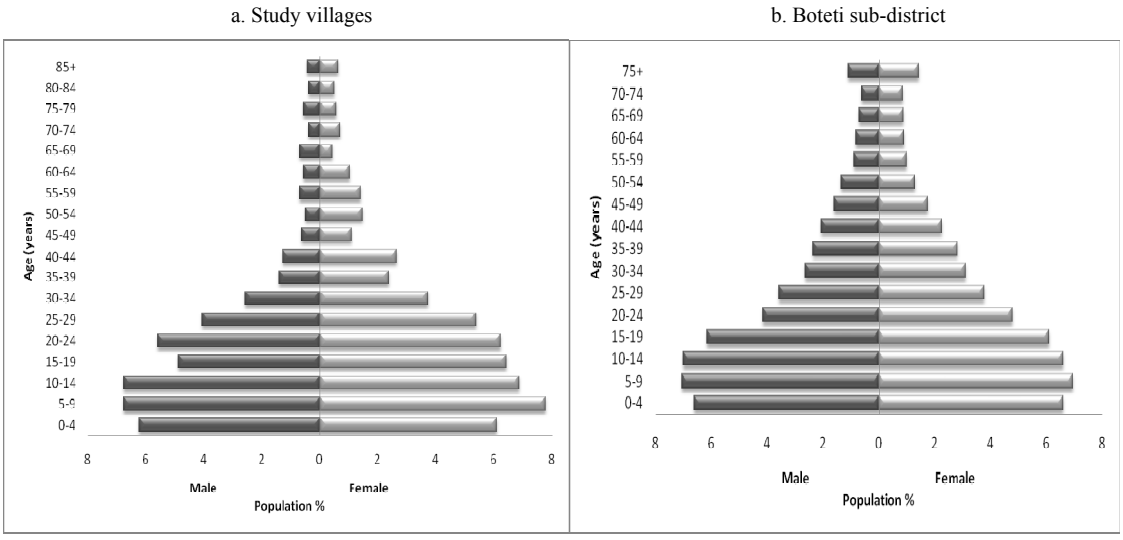

Figure 6: Age distribution of household members in the study villages and the Boteti sub-District

Population age/sex distribution provides insight on general fertility and mortality trends that are crucial as key drivers for population growth and decline. Population growth usually increases demand for water in all sectors of the economy (Bandaragoda, 2000; Roudi-Fahimi *et al.*, 2002). A young population such as the one in the study villages is a growing population which also has bearing on increased water use and demand. Population growth in the Boteti sub-Basin has been noted as one of the drivers of environmental change resulting in lack of opportunities and poverty (Scudder *et al.*, 1993; Vanderpost, 1995). When developing integrated management of resources, general population characteristics may help managers to plan for future growth in water demand and ultimate need for proper allocation of water.

4.2.2 CHARACTERISTICS OF HOUSEHOLD HEAD

The majority of households (60.5%), in the study villages, are headed by women either as *de jure*- (widowed/divorced/never married, 48.8%) or *de facto*- (male head away, 11.7%) household heads. A higher percentage of *de jure*-female-headed households, in Botswana, have often been linked to large household size and low living levels (Ministry of Finance and Development Planning [MFDP], 1994).

The majority of household heads have low education with a total 76.6% of them with "none" to "primary" level of education, and 73.6% of them are unemployed (see Table 3 below).

Table 3: Demographic and socio-economic characteristics of household head in the study villages

Demographic/socio-economic variable		**Frequency % (n = 293)**
1.Gender	Male	45.4
	Female	54.6
2.Age	<29years	10.1
	30-39years	22.0
	40-49years	19.7
	50-59years	17.0
	60-69years	13.3
	70-79years	9.2
	80years and over	8.7
4.Marital status	Married	35.4
	Single	25
	Widowed	18.1
	Cohabiting	17.7
	Divorced	3.8
5.Highest education attained	None	44.4
	Primary	32.2
	Junior secondary	17.2
	Senior secondary	2.3
	Tertiary	1.9
	Other	1.9
6.Ethnicity	Yei	24.7
	Kalanga	22.3
	Nambjwa	22.0
	San/Sarwa	7.7
	Kgalagadi	3.8
	Other	19.5
7.Religion	Christian	68.7
	Traditional	28.5
	Other	2.7

At national level the proportion of household heads with education level "none" to "primary" is as high as 83.3% mostly men (Central Statistics Office, 2004). The mean household size is 6.4 persons which is a larger household size than the national average of 4.4 for rural households. All these indicators have implications for possibly low living levels especially when combined with 74% of the household heads being unemployed. In Botswana, low living levels that result from lack of opportunities have often been associated with increasing poverty and high dependence on the environment for survival (Ministry of Finance and Development Planning, 1994). The low levels of education and the associated lack of significantly marketable skills are associated with high unemployment and low living levels. These may in turn result in high dependence on nature based livelihoods as would be discussed in later sections.

Ethnic composition of the sample shows that the majority are the Yei (24.7%), followed by the Kalanga (22.3%), Nambjwa (22%), the San/Sarwa (7.7%) and the Kgalagadi (3.8%) while other ethnic groups such as the Ngwato, Tawana, Khurutshe, Herero and Hambukushu account for less than 3.8% respectively. The Boteti River sub-Basin is one of the most ethnically diverse areas in Botswana, with the different ethnic groups having various land use types that differ from the rest of the country. For instance, while most ethnic groups mentioned above are mainly arable-pastoralists as in most parts of Botswana, the Yei are well renowned for *molapo* farming, good skill in water navigation through the use of the *mokoro* or the canoe, use of aquatic plants for food as in the case of *tswii* (*Nymphaea* spp), and *tjita/tsita* (*Typha capensis*); and the San are mainly hunters and gatherers. Ethnic composition may be very useful to explain general resource use patterns and provide insight on cultural practices useful for natural resources management. The Boteti sub-Basin as would be shown in the livelihoods section, has

significant proportion of *molapo* or flood recession cultivation and this is attributable to the significant proportion of the residents being of Yei ethnic group.

4.2.3 HOUSEHOLD SOCIO-ECONOMIC CHARACTERISTICS

The socio-economic characteristics investigated in the study villages include type of housing, and forms of energy used for lighting, heating and cooking. Type of housing can be used to reflect on the various types of resources used by households. These may also shed light on adaptation to changing environmental conditions including water availability. The results show that the main type of housing in the study villages are traditional housing comprising mud walls and thatched roof. Though these account for 46.2% of all households they are a dominant feature in those households that have a mixture of modern and traditional types of housing in all the four villages. The mixed type of housing units accounts for 41% while the modern type accounts for 12.8%. A break-down of data by village (Figure 7) shows that the traditional type of housing is dominant mainly in Kedia (54.3%) compared to the other villages.

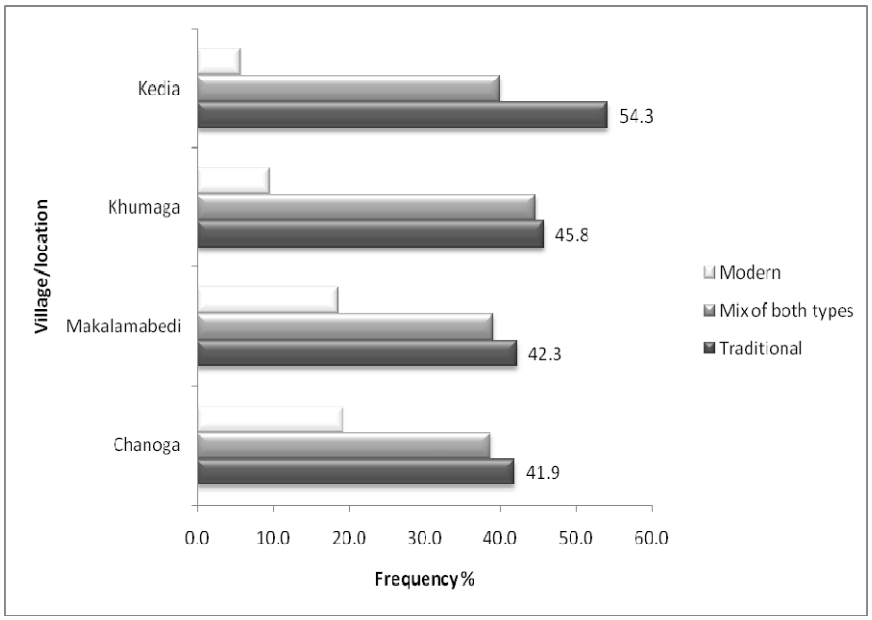

Figure 7: Types of housing structures in the study villages

Conversely, the modern type of housing is lowest in Kedia (5.7%) compared to the other villages.

The dominance of traditional housing structures mainly made from mud, wooden poles, thatch grass and natural fibre used for tying, indicates high dependence on naturally derived material for housing. Most of these materials are obtained by households either directly or purchased from those who harvested. Further probing has revealed that for traditional houses the thatched roof usually takes three years or less before the next refurbishment, while the mud walls require maintenance annually. The environmental impacts of maintaining these houses is unclear and it can be thought to be minimal for inputs such as soil, grass and tying fibre while the extraction of poles from trees could have significant impact. The harvesting of woodland resources for energy and construction has been identified as one of the causes of deforestation in large villages in

Botswana (Ministry of Finance and Development Planning, 1994). However, these could be new areas for research since they are not key to this study.

For water management in the Boteti sub-Basin, land resources use, such as in housing, helps explain water use as most settlements are found along the river. Informal discussions have revealed that building materials, for traditional housing, have changed significantly in the Boteti sub-Basin reflecting the current prolonged drying of the river. In the past, some building materials in settlements along the river included riverine reeds, used for constructing hut walls, as is the case with most settlements found in the Okavango Delta. This indicates a shift from dependency on aquatic to terrestrial resources.

In addition to household types, forms of energy used for lighting, heating and cooking were also investigated in the study. These can serve as indicators of the level of dependence on naturally derived products. The results indicate that the main type of energy used for lighting is paraffin which is used by 51% of all households followed by candle at 20% while 21.7% used both candle and paraffin as energy sources for lighting. Even at the national level paraffin dominates as a source of energy for lighting being used by 53.2% of households (Central Statistics Office, 2004). When the data are disaggregated by location, paraffin and candle still dominate as key sources of energy for lighting. As shown in Table 4 below, paraffin is the main source of energy for lighting in all the study villages except in Chanoga where a larger percentage of households use both paraffin and candle as their main source of energy for lighting.

Table 4: Percentage frequencies of households, source of energy used for lighting by location

Type of energy source		Chanoga	Makalamabedi	Khumaga	Kedia
Paraffin		32.4	54.0	66.7	38.6
Candle		29.4	21.0	11.9	24.3
Both candle and paraffin		35.3	25.0	14.3	20.0
Firewood		0.0	0.0	4.8	14.3
Solar energy		2.9	0.0	0.0	0.0
Other		0.0	0.0	2.4	2.9
Total	%	100	100	100	100
	n	34	100	84	70

Solar energy is also used by only 2.9% of households in Chanoga. Currently there is no power grid in all the study villages and very few households generate electricity using small generators. The results point to less dependence on local resources for lighting. The use of locally available resources for lighting such as firewood is lower in all the study villages. Paraffin and candle are mostly imported products.

The majority of households in all the study villages use firewood as a source of energy for heating and cooking. Percentage frequencies, as shown in Figure 8 below, point to a high proportion of households that use firewood for heating and cooking ranging from 78.1% in Makalamabedi to 98.6% in Kedia.

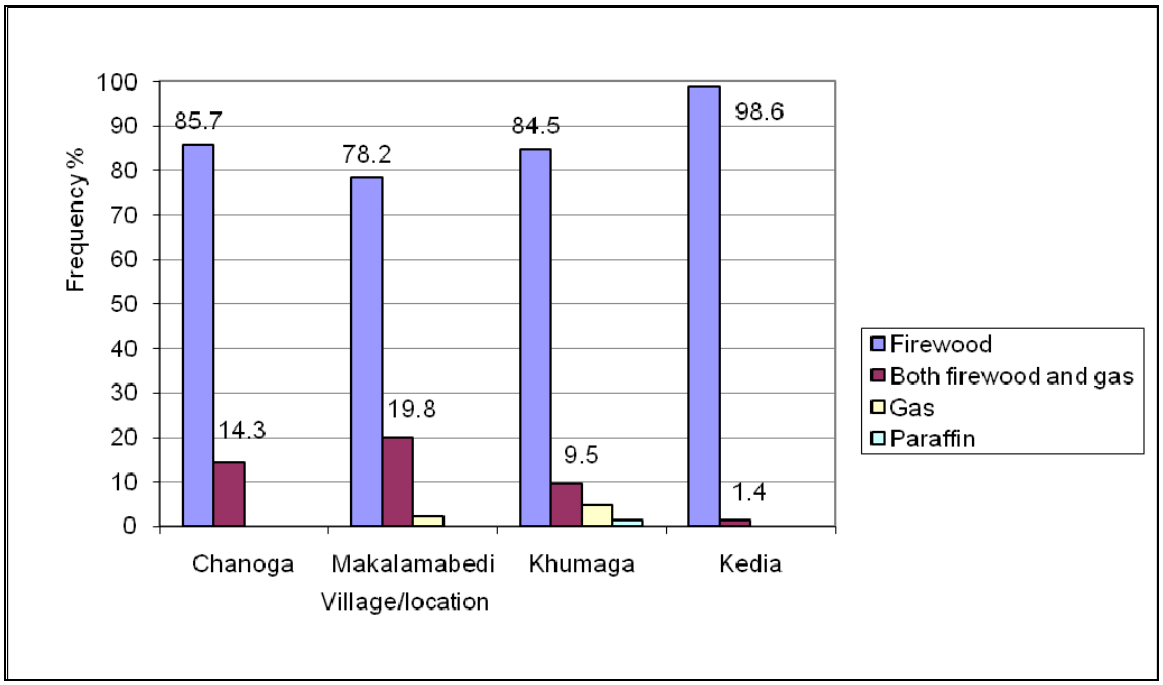

Figure 8: Percentage frequencies of households by sources of energy for heating and cooking

The proportion of households that use both gas and firewood is still low ranging from 1.4% in Kedia to 19.8% in Makalamabedi (Central). At the national level firewood is used by 81% of rural households (Central Statistics Office, 2004). This shows that households in the study villages depend on woodland resources, mainly trees, to meet their energy needs for heating and cooking. It also implies that not much energy source substitution away from firewood has occurred in the study villages. Further probing has shown that most households, in the study villages, acquire firewood directly from the veld rather than buy from others. While this is an indication that there is minimal commercialisation of firewood in the study villages, it does not rule out major removal of vegetation mainly trees in the vicinity of all the study villages.

The overall results in this section mean that women, as the main household heads are key in the use of natural resources in the Boteti River sub-Basin and their active involvement in integrated management of the sub-Basin is crucial. Their low education, high unemployment rate and their dependence on natural resources for building houses and energy sources, mean that efforts should be made to reach out to most of them with a view to including them in most decisions on the management of water and terrestrial resources in their area. IWRM should be contextualized within the broader concept of integrated natural resources management for it to be more relevant to people's livelihoods (Biswas, 2004; Merrey *et al.*, 2005; Van der Zaag, 2005; Jonker, 2007; Lankford *et al*., 2007; Merrey, 2008).

4.3 TYPES OF LIVELIHOOD ACTIVITIES

When developing integrated management of resources for ephemeral river basins, it may be useful to consider types of livelihoods dominant among communities within such river basins. Knowledge of types of livelihoods can inform decision making on water. In this section respondents were asked to state all livelihood activities their households are involved in, as well as rank the livelihoods according to four levels of "most important", "second important", third important and "fourth important". The households indicated more than one livelihood activity and provided the ranking.

The main livelihood sources are dryland arable farming and livestock farming. These activities are undertaken, as shown in Figure 9 below, by 62.5% and 58.4% of all households, respectively.

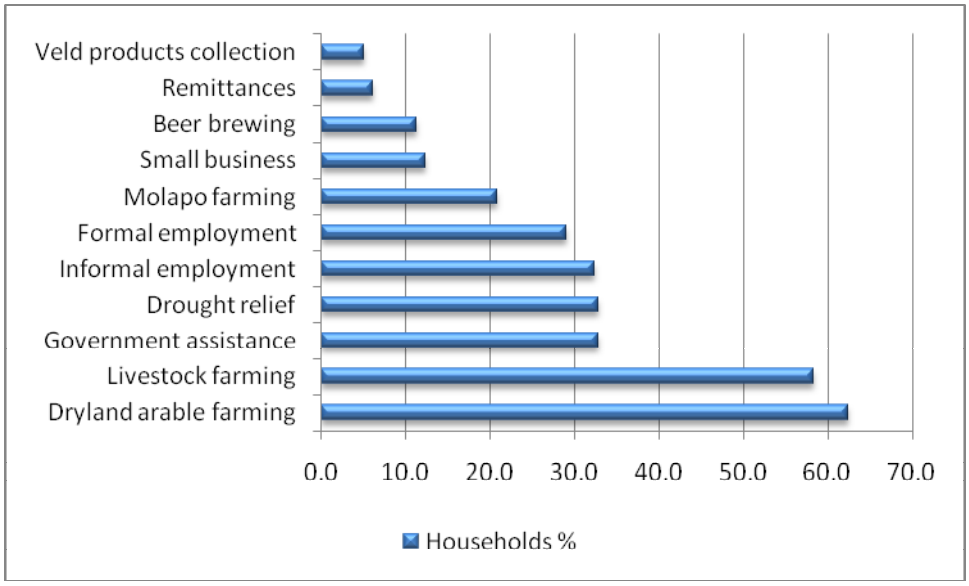

Figure 9: Types of activities undertaken by households in the study villages

Other livelihood sources are government assistance, drought relief/labour- intensive-public- works, formal and informal employment. These are undertaken by less than 40% of all households interviewed in the study villages. Worthy to note is that while there is clear dominance of arable and livestock farming among households, these are closely followed by government assistance and drought relief/labour-intensive-public-works. Government welfare schemes benefit mainly the elderly, orphaned children and the destitute while drought relief programmes benefit mainly the unemployed.

This shows the effect that livelihood shocks, such as the HIV/AIDS pandemic and drought, have on households in the Boteti River sub-Basin. Dependence on these livelihood types shows households' reduced ability to sustain themselves. Informal employment, mainly in small businesses, livestock herding and miscellaneous "piece" work/jobs, also benefits less than 30% of households. These underscore the low living levels among most households since they usually attract low wages. In addition to these

activities, *molapo* farming, small business, beer brewing for sale, remittances and veld products collection, are a source of livelihood for less than 20% of households, in what Campbell (1971) cited by Vanderpost (1995, p526) calls a "diversified subsistence package". The various combinations of different livelihood activities within a household indicates households' responses to minimize risk from shocks such as drought, animal and human diseases and major fluctuations in river flow (Kgathi *et al.,* 2004).

Further ranking of livelihoods indicates that livestock farming is the most important livelihood activity. However the difference between the two livelihoods, livestock and arable farming, in terms of level of importance to households is not very high. In all the households interviewed, 24.2% stated that livestock is the most important source of income while 22.5% stated that arable farming is the most important. Other livelihood activities were stated by 1 to 15% of all households.

The study, further reveals that only 41.6% of the households interviewed own cattle, 36.1% own goats and 26.5% own poultry, the main livestock types kept for subsistence and need based income generation (see Table 5).

Table 5: Household ownership of livestock in the study villages

Type of livestock	Household ownership %	Mean no. livestock
Cattle	41.6	9.1
Goats	36.1	5.5
Poultry	26.5	2.2
Donkeys	36.3	1.9
Horses	12.5	0.4
Sheep	3.4	0.3

The mean number of cattle per household is 9.1 while that for goats is 5.5 and poultry 2.2 and this underpins the subsistence nature of livestock farming in the area. Livestock ownership is uneven in Botswana with fewer households owning large herds and most households owning an average of 1 to 9 units of all types of livestock (Central Statistics Office, 2004). In the study villages, livestock ownership seems biased towards cattle and goats with these two types of livestock being more than other types in per unit terms. Swatuk and Motsholapheko (2008) also noted that these types of livestock are the mostly kept in the Boteti River sub-Basin.

Informal discussions, with some residents in these study villages, revealed that cattle and goats are most important for cash income, provision of milk and meat for immediate household consumption as well as for social functions such as weddings, funerals and community festivities. They also serve as household income security as well as a status symbol. Cattle can also be used for draught power. Other types of livestock owned by

households are donkeys, horses and sheep, the first two being used for draught power while sheep, though not commonly kept, are also used for subsistence purposes.

Most livestock owning households (58.4%) stated that they keep their livestock either inside or outside the village while the rest keep their livestock at the cattle-post usually not very far from either the village or the river. The mean distances of the place where livestock are kept from the village and the river are 5.6km and 1.9km, respectively. This underscores the importance of both the village as a source of social services and the river as the sustaining anchor of these livelihoods in water provision. Ecosurv (2008) also found that most cattle-posts are located at well points and boreholes along the Boteti River.

The dominance of subsistence arable and livestock farming as sources of livelihood in the Boteti sub-Basin is still valid today as it was in the past decade. This is shown in this and other studies that emphasized the importance of these livelihoods to the inhabitants of the sub-Basin (Scudder *et al.*, 1993; Arntzen *et al.*, 1994; Vanderpost, 1995; Hydrogeo (Pty) Ltd and Water Surveys (Botswana), 2001; Scott Wilson Kirkpatrick and Partners & Ecosurv (Ltd), 2002; Mazvimavi & Mmopelwa, 2006).

Though dryland arable farming and livestock farming support the lives of the majority of the households they do not contribute enough to lift many households out of poverty. They are immediately followed, in terms of importance, by government social welfare and drought relief programmes. This is because of the harsh bio-physical conditions of frequent droughts, drying of the river and the incidence of human and animal diseases (Vanderpost, 1995). In addition the management practices such as open grazing make it

difficult to control livestock numbers and distribution in communal areas. Some areas especially along the river, and near the villages, have large concentrations of livestock possibly leading to over grazing and denudation of vegetation.

These key livelihoods should be the centre of focus for identifying community stakeholders needed for participation in water resources management. This is where most households invest their time and general effort. Some of the environmental challenges such as overstocking, overgrazing, exposure of the soil to wind erosion, and general degradation, noted in some sections of this study, are related to these major sources of livelihoods.

A livelihood approach to integration, based on strong community participation, can help modify service provision making it relevant to community environmental needs (Bandaragoda, 2000; Merrey, 2008). Most livelihood activities in the sub-Basin are dependent of water (either surface or groundwater) availability in the river. The environmental challenges particularly those associated with human activities result from household strategies adopted to cope with risk caused by shocks. An integrated water resources management approach, that targets key areas of household needs, avails new ways to cope with risks and improves general livelihoods, reducing dependence on the natural environment is likely to attract support from local communities and bring tangible benefits.

4.4 TYPES AND PATTERNS OF WATER USE

Types and patterns of water use are important since they reveal water demand by individual households as well as types of water sources available for water supply.

Development of water supply sources is usually a response to water demand. In this section, households were asked to state the purposes for which they use the Boteti River water, indicate where and how they obtain water for various uses, the distance to water sources as well as the challenges they face in water use in their villages.

4.4.1 TYPES OF WATER USE

The use of river water can help reveal types of water use as well as the level of importance that households attach to the river as a source of water. In this section households were asked to state what they use river water for and they were allowed to state all their various uses. Most households in the villages of Chanoga, Makalamabedi (Central) and Khumaga indicated that they use Boteti River for livestock watering. Percentage frequencies as shown in Figure 10 below indicate that Chanoga has the highest proportion of households (83.3%) that use the Boteti River water for livestock followed by Khumaga (66.1%) and Makalamabedi (Central) (64.3%).

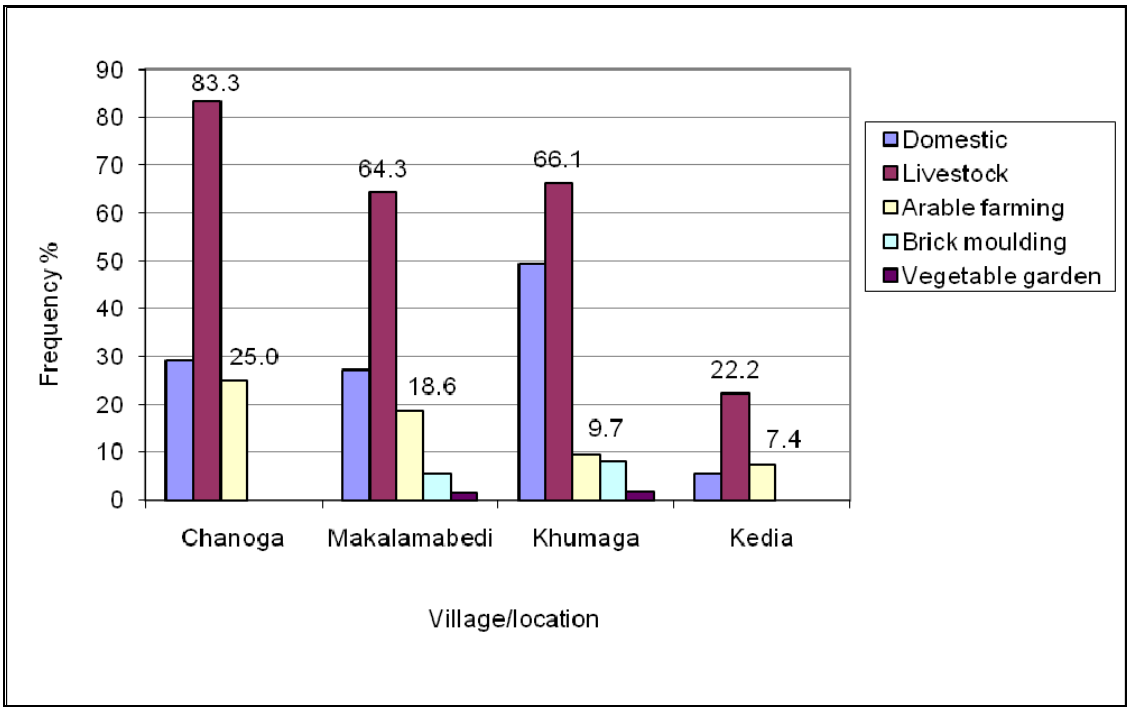

Figure 10: Percentage frequencies of households by type of water use in the study villages

In Kedia very few households (22.2%) indicated that they use the river water for livestock.

The three villages, of Chanoga, Makalamabedi (Central) and Khumaga are located along the river with clear-cut river banks and shallow water tables easily reachable through hand dug wells. The villages of Chanoga and Makalamabedi (North West) are in the flooded upper area of the Boteti River where farmers water their livestock directly in the river. Some residents of these villages indicate that they use river water for watering of vegetable garden and brick moulding. Field observation and informal discussion with residents of these villages have revealed that there is subsistence fishing and small scale commercial fishing in these villages. Kedia is situated near the now defunct Lake Xau, a vast area of generally flat grassland, and most residents no longer see the literal connection between water availability and the river.

A larger proportion of Khumaga residents (49.2%) also use Boteti River water for domestic purposes while very few in the other villages use it for this purpose. This may be due to frequent water shortages as well as high salinity of water in the village water supply system. Informal interviews revealed that there were frequent water shortages due to low yield in the borehole that supplies the village. The residents frequently use water from their hand dug wells, mostly located in the river. Similar shortages were also reported in Chanoga and Makalamabedi where some households used water directly obtained from the river, when the village water supply breaks down.

4.4.2 WATER USE PATTERNS

The patterns of water use may provide insight into the causes of various problems encountered by households. In order to identify and assess the patterns of water use, households were asked to state where and how they obtain water for various purposes, distance to water sources as well as household decision making on water use. Households were also asked to state the challenges they face in the use of water. As indicated in sub-section 4.4.1 the Boteti River water is used mainly for livestock watering, domestic and arable farming purposes and that this varies according to village or location.

4.4.2.1 LIVESTOCK WATER USE PATTERNS

In order to obtain data on livestock water use patterns, households were asked to state where they obtain water for their livestock as well as indicate the time spent watering their livestock. They were also asked to state whether they own hand dug wells as well as how they obtained them. Such information may be useful to determine allocation of

labour time and access to water for livestock. The results for all villages show that water used for livestock is mainly obtained from hand dug wells (60.1%) located along the river bed. However, the source of water for livestock differs according to location within the sub-Basin. Households in the villages located in the upper sub-Basin villages of Chanoga and Makalamabedi (Central) directly water their livestock in the river whereas those in the mid- and lower sub-Basin villages of Khumaga and Kedia, respectively, water their livestock using hand dug wells located along the river bed. As shown in Table 6 below, 95.2% and 79.6% of all livestock owning households in the upper sub-Basin villages of Chanoga and Makalamabedi (Central) respectively, indicated that they water their livestock in the river while 4.8% and 13.0%, respectively, water their livestock from hand dug wells.

Table 6: Percentage frequencies of types of water sources used for livestock by village/location

Village/location	River	Hand dug well	Village water supply	Other
Chanoga	95.2	4.8	0.0	0.0
Makalamabedi	79.6	13.0	0.0	7.4
Khumaga	0.0	100.0	0.0	0.0
Kedia	0.0	91.6	4.2	4.2

Source: Field data. n=140

In the mid- and lower sub-Basin villages of Khumaga and Kedia the majority of households water their livestock from hand dug wells.

From these results, most households in the upper sub-Basin use surface water for their livestock while those in the mid and lower sub-Basin use groundwater mainly from hand dug wells to water their cattle. Integrated management of surface and groundwater in the sub-Basin should therefore take cognizance of these spatial differences. When involving communities, for instance, surface water protection may be given more emphasis in the upper sub-Basin while groundwater protection is given more attention in the mid- and lower sub-Basin. However, this does not imply that either should be ignored based on this spatial consideration. There are a small number of farmers who have stated, though reservedly, that they water their livestock, mainly donkeys and goats, from stand pipes at home or public water taps. These make up 4.2% of all the households interviewed only in the village of Kedia. Implications for this will be further discussed in the section on domestic water patterns.

Informal interviews revealed that water from hand dug wells is drawn using different methods such as hand buckets, windlass and bucket (swinging bucket) and motorised pumps. These methods particularly the bucket methods provide water at very little or no financial costs. They mainly require labour input from household members or their relatives. Motorised pumps are used mostly by the well-to do households who can afford the costs of running them. Considering the low number of livestock per household, the mainly subsistence nature of livestock farming in the sub-Basin, and that most households do not use devices that draw huge amount of water per time we may have insight on why most areas in the mid- and lower sub-Basin have not depleted the supposedly thin layer of low saline water in these parts of the sub-Basin. Water

consumption may be generally low making it possible for low saline water to be available for long periods of time.

In order to obtain data on access to water for livestock, households were further asked to state whether they own hand dug wells. They were also asked to state how they obtained them. The results show that 51.3% of all households, interviewed in the four study villages, 'own'[5] hand dug wells. A break down of data by village indicates that a higher proportion of households in Khumaga (73.3%) 'owning' hand dug wells compared to the other villages. The results also show that Chanoga has the lowest proportion of households (10.7%) that 'own' hand dug wells while Makalamabedi (Central) and Kedia have shown equal proportions (50%).

The Boteti River has not had flowing water in most parts for the past 17 years. The section of the Boteti River in the Makalamabedi (Central) area only had water for the first time in 2007 and most people still depended on hand dug wells. The areas in the mid- and lower sub-Basin have not had any water in the entire period since 1991 and most livelihood activities in the area depend on groundwater which is reachable through hand dug wells in the river bed.

Most hand dug wells (67%) are self allocated since the land board had for a long time not considered licensing them, particularly those located in the river bed. This may have resulted in the proliferation of these wells leading to high concentrations of livestock and degradation of most areas near the river. Arntzen *et al.* (1994) also found that there were high concentrations of livestock and observed degradation in areas within and near river,

[5] 'Own' because they are not legally allocated

around villages and overstocked boreholes. They also associated these to the many hand dug wells that are close to each other. These environmental challenges were also confirmed by a focus group discussion held with some community representatives.

Currently, the land board requires farmers to register hand dug wells with a view to regulating their proliferation. While their formal non-regulation may have opened up their proliferation in the past, there is potential for self regulation among owners that can synergistically support this land board action. Informal interviews have revealed that community members view them as potential hazards when submerged under water during flooding. Further, some unwritten rules observed within some communities can also play an important role.

4.4.2.2 DOMESTIC WATER USE PATTERNS

In this sub-section households were asked to state where they obtain water for various domestic uses, the distance to such sources, water use consumption and the roles of various household members in intra-household water management. Households were also asked to express their opinion on use of public water reticulation systems.

The results indicate that the village water reticulation system, through public water taps and private connections, is the main source of domestic water for households in all the study villages. Interviews in all households in the study villages indicate that this system is used by 99.3% of all households for the domestic purposes of drinking, washing/bathing and home construction. Only 0.7% of all households use other sources such as hand dug wells and, in upper sub-Basin, direct collection from the river. These findings are consistent with other studies in rural villages of Botswana where the general indication is that access to piped drinking water is high. Ngwenya & Kgathi (2006) found

household access to piped water to be a cumulative 94.5%, while Kelekwang & Gowera (2003) found that access to potable water in rural villages with population of 1000-4999 people was at 96.5%. These are further confirmed by Mazvimavi & Mmopelwa (2006) who found that all households in the gazetted settlement of Chanoga had access to piped water.

The results also show that the mean amount of water used by households per day, for drinking, washing clothes, home construction and bathing is 32.1 litres, 55.4 litres, 150.4 litres and 31.3 litres, respectively. These results compare very well with those of a study on access to water in the rural villages of Ngamiland, where Ngwenya & Kgathi (2006) found domestic consumption per household, mainly for personal use, to range from 55 to 82 litres per day. Further open discussions with respondents have revealed that washing of clothes is done weekly while water for home construction is needed seasonally and mostly at the end of winter. They also revealed that water for home construction is usually grey water from bathing and washing clothes. The use of this grey water reduces the burden of drawing large amounts of water, since this activity requires more water, and extra effort in water collection. This is crucial for water management, and can provide a useful entry point towards household awareness on water reuse for other purposes.

The most commonly used method of water collection is the head-bucket/hand-held container and it is used by 83.7% of all households interviewed. Other methods used by households in the study villages are the roll-over tank/wheel burrow, donkey cart and motor vehicle. These are used by a cumulative 16.3% of all households. The mean distance to stand pipes in the study villages is 322.2 metres. The method of water collection depends on distance to water points. Mazvimavi & Mmopelwa (2006) found

that where water collection points are beyond 500 metres, households in un-gazetted settlements of Ngamiland used donkey carts.

Households were also asked to state who collects water for domestic purposes, who decides how water should be used in the household, as well as the amount of water, per day, used for drinking, washing, bathing and for home construction. This was meant to obtain data on intra-household water management and consumption patterns. The results indicate that all household members collect water and that women generally decide on how water should be used in the household. These are the modal categories or responses to the questions, "Who collects water for domestic purposes?" and "Who decides how water should be used in this household?" at 34.7% and 59.3%, respectively. It is understandable that the results show that women are key in household decision making about water use, the majority of households interviewed are headed by women as shown in sub-section 4.2.2. Women are the main decision makers on water use at the household level. Therefore their inclusion in water management in the Boteti River sub-Basin is crucial.

Households were also asked to give their views on the challenges facing public water reticulation systems. Some of the challenges were listed and respondents were asked to state whether they "strongly agree", "agree", "neither agree nor disagree", "disagree" and "strongly disagree". The results show that the majority of households agree with the statement that "Public stand pipes are vandalised and culprits are rarely identified. From all the households in the study villages, a cumulative frequency of 73.7% stated that they "strongly agree" (57.5%) or "agree" (16.2%) with this statement. A large proportion of households (70.8%) also stated that they agree with the statement that, "Livestock

frequently damage public stand pipes", 53.8% "strongly agree" and 17% "agree". However, households disagreed with the statement that, "There is generally no monitoring to ensure proper use". As shown in Table 7 below, a cumulative 56.9% of all households interviewed either stated that they "strongly disagree" (14.2%) or "disagree" (42.7%) with this statement.

Table 7: Percentage frequencies of households' perceptions on public stand pipes in all the study villages

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
Public stand pipes are vandalized, culprits rarely identified	57.5	16.2	9.7	7.3	9.3
Livestock frequently damage them	53.8	17.0	8.3	9.5	11.4
There is generally no monitoring to ensure proper use	22.3	12.7	8.1	42.7	14.2
Some community members water their livestock during the night	21.7	7.0	29.8	27.5	14.0

These results point to lack of sense of ownership of public standpipes among households in the study villages. Key informant interviews have further shown that the district council has, in each village, assigned borehole operators who, in addition to the running of the borehole that supplies the village, also monitor the use of public standpipes. However, misuse and vandalism continues though community members are aware of acute water shortages that result from such actions.

There is also a small number of households who have stated, though reservedly, that they water their livestock, mainly donkeys and goats, from stand pipes at home or public water taps. These make up 4.2% of households only in the village of Kedia. While this proportion of households is very low, mainly because of the heinous outlook of such action within the community, it indicates that use of public water reticulation systems for watering livestock occurs and may help explain the frequent damage to public stand pipes by livestock in all the villages in the study area.

Households do not feel obliged to take care of these facilities though they are aware of their importance to household wellbeing. District council plans to curb water wastage and abuse by installing pre-paid standpipes. Households will be issued free water rationing cards to obtain water from public standpipes up to a certain amount (Central District Council, 2003). In this case users can only turn the tap on by using the card and any water wasted will be taking away the amount due to the user. Any amount exceeding the set quantity will require users to pay allowing them more water to meet their extra requirements. While this is technically possible and can reduce wastage, it is most unlikely to prevent vandalism and possible use of these facilities to water livestock. Some households may still purchase more water for livestock while some individuals may continue vandalizing them to obtain water for their livestock.

Engagement of community members especially at household level through organising household level committees may help create a sense of ownership. The users of a particular stand pipe form a stable group that can be encouraged to take keener interest in

its condition (Ahlberg *et al.,* 1988). The current free access system opens up these facilities to abuse as this is common in most free or open access conditions.

At community level, the village water reticulation system, as the main source of domestic water, can provide entry point for applying IWRM principles in more understandable ways for households. Modification of the current approach of supply for domestic water only can help include water use for other productive activities.

4.5 PARTICIPATION AND WATER MANAGEMENT INSTITUTIONS

In this section, some roles played by the main water management institution, the district council, and the local level water related institutions, are described and some issues surrounding water management are put into perspective. Community participation through local committees is assessed by looking at general awareness, among households. Some of the problems peculiar to the village Makalamabedi (Central), due to its geographical location along the district boundary between the North West District and the Central District, are highlighted.

In all the study villages, as is the case with all settlements of their size, water is supplied by the district council. This is done through the village water reticulation system that avails water for households through private water connections and community standpipes. The system is managed and maintained by the district council with little (for private connections) or no cost to households. The rationale for this is that provision of clean potable water to communities supports local level economic growth and prevents water borne diseases (SMEC, 1991; Mazvimavi & Mmopelwa, 2006). The village water supply scheme is generally very expensive to maintain resulting in water supply

inefficiencies and general failure to maintain a consistent supply of good quality water in some areas (SMEC, 1991; Swatuk & Kgomotso, 2007). Household interviews have confirmed that in all the study villages there are frequent water shortages, and in some such as Chanoga, Khumaga and Kedia the water supplied is of poor quality due to lack of water cleaning facilities.

The Boteti Sub-District Council is responsible for supplying water to Makalamabedi (Central) village. The Sub-District Council is based at the administrative major village of Letlhakane. The village of Makalamabedi (Central) is supplied with water from the neighbouring village of Makalamabedi (North West) that falls under a different water authority, the Ngamiland Sub-District Council. However, an arrangement has been made for the Ngamiland Sub-District Council (based in Maun, 50km away) to supply water to Makalamabedi (Central) while installation, maintenance, and water fees are the responsibility of the Boteti Sub-District Council.

Some households stated that they experience frequent water shortages sometimes lasting from a few days up to more than a week. Key informant interviews have revealed that water shortages in Makalamabedi (Central) result from some maintenance problems at the water desalination plant in Makalamabedi (North West). These include machine breakdowns, slow pace of repairs, failure to replenish water treatment chemicals on time and broken water pipes. Some public water pipes are also shut down by the water supply operator following damage by either livestock or water users. Additionally, there is a problem of failure by the Boteti Sub-District Council, to collect water fees on time resulting in non-payment among households, with private connection. Some respondents

have expressed the difficulty of having to travel to the nearest revenue office in Rakops (approximately 120km away) to pay water bills.

Both sub-district councils fall under the same Ministry of Local Government but the Ngamiland Sub-District Council cannot collect water fees from residents in Makalamabedi (Central). The case of Makalamabedi (Central) highlights the difficulty of managing a natural resource according to political boundaries. It would be more cost effective for repairs to water pipes and collection of water fees to be taken care of by a water authority based 50km away instead of 120km (or 250km in Letlhakane, the Central District headquarters). For administrative reasons this cannot be done since each district has its own structures that are accountable to the council secretary in the respective head offices. Even within the district council itself the various units or departments work independently. This setup is not peculiar to district councils alone it is inherent within the whole water governance system in Botswana where sectoral units or departments have vertical reporting lines and authority with weak or no horizontal linkages (Swatuk & Rahm, 2004; Magole, 2008).

4.5.1 OTHER WATER RELATED INSTITUTIONS

At the lowest level of village communities, the village development committee (VDC) plays a major role in water management. It mobilizes manual labour in the construction of village water reticulation systems, provides funds for the construction of enclosures around public standpipes, contributes to decisions on the number and location of public standpipes required in the village, and encourages proper use of these facilities among community members (Kgathi *et al.*, 2004; Ngwenya, 2008). This was also confirmed by

key informant interviews in the study villages. These efforts by a community-centred organization, serve to support water provision by district council.

In order to determine level of knowledge on local institutions in the study villages, households were asked to give names of local committees they know exist in their village. They were also asked to state whether any member of their household members is a member of any of these committees. They were further asked to state whether they know of any cultural rules used in the management of water resources as well as state whether the Boteti River was in the past managed in ways that were different from the current approaches.

The results indicate that only the village development committee (VDC) is the most well known to exist in the study villages. The households were allowed to mention more than one committee in order to determine their understanding of community participation in their village affairs. Of all households interviewed in the study villages 77.1% mentioned the VDC whereas other committees such as the parents and teacher association (PTA), village health committee (VHC) and the youth committee were mentioned by 45.4%, 22.9%, and 20.8% of all households, respectively (Table 8).

Table 8: Percentage frequencies of households by villages committees known to exist in the study villages

Type of committee	Frequency %
Village development committee	77.1
Parents and teachers association	45.4
Village health committee	22.9
Youth committee	20.8
Farmers committee	16.4
Crime prevention	15.0
Community trust	11.9
Conservation committee	3.1

n=293

According to the 2001 National Population and Housing Census, all the four study villages, fall under "rural" category of villages where up to 75% of their population is involved in agricultural activities. The results on livelihoods have also shown that most households depend on or are engaged in agricultural activities. The irony is that the farmers' committee is one of the least known committees in these villages. It was mentioned by 16.4% of all the households in these villages. This apparent lack of knowledge about most committees especially the Farmers' Committee, among households that mainly depend on livestock and arable farming is surprising. It may imply that households are passive recipients of services from the related sectoral department. SMEC (1991) noted that the spirit of self reliance that used to exist, among

most communities in Botswana has been eroded and ultimately decimated by increased government support that required no input from recipients.

However, some communities still maintain an appreciable level of community participation to deal with some pressing challenges. The conservation committee is also one of the least known, being mentioned by only 3.1% of all the households in the study villages. It is only in the village of Chanoga where there is an active conservation committee. Open discussions with some respondents in Chanoga have revealed that the committee is actively involved in environmental awareness and has recently been advising small scale commercial fishers to prevent water pollution in the river. This was as a result of growing concern among community members that the fishers were not handling fish waste properly leading to water contamination in some key livestock watering points along the river. The committee has successfully lobbied for the expulsion of those fishers who continued dumping fish waste indiscriminately. It has also mobilised community members to form a community trust that would apply for land rights in Chanoga and manage resources in the area.

Households were further asked to name village committees that they think enjoy the most support in the village. This was meant to identify village committees that can effectively support community participation in integrated management at the local level. The results, as illustrated in Figure 11 below, indicate that 64.9% of all households in the study villages named the VDC followed by the parents and teachers association at 21.5% while other committees all account for 13.6%.

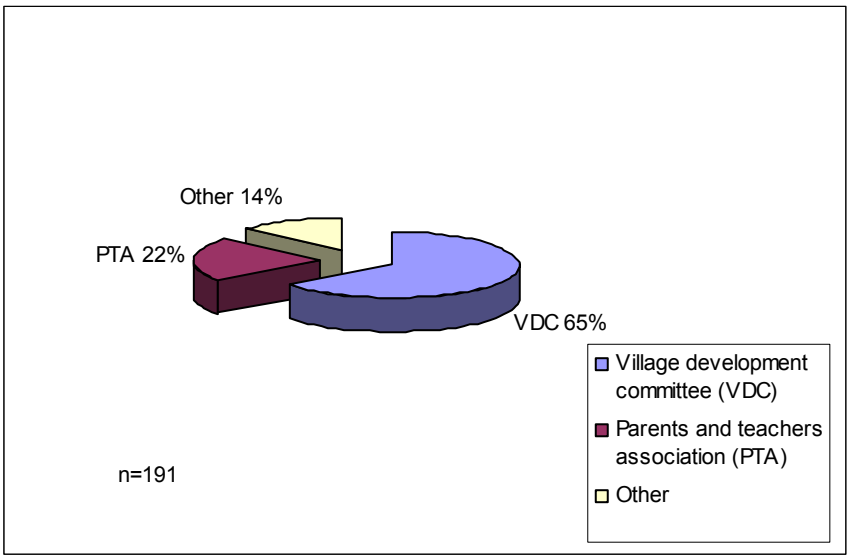

Figure 11: Percentage distribution of households by village committee that enjoys the most support in all the study villages

This underscores the importance of the VDC in community participation in all the study villages.

Households were further asked to explain why the committee enjoys the most support in the village. Most households indicated that the VDC enjoys the most support because it is close to the community and plays leading role in village development, its members are paid allowances and that all other committees fall under it. The closeness to the community indicates that it serves most people's interests. Households have expressed their keen interest in the committee in their reference to it as the "village parliament". When further asked to explain this some households indicated that this committee is voted for by the community members and as such made up of true representatives of the community. On whether the committee serves the basic legislative function of "parliament" some households indicated that this committee makes some of the basic rules that shape community behaviour, and that it is the main decision making body at the

local level. The findings on level of knowledge about the VDC and its general appreciation among community members correspond with those by Ngwenya (2008).

The comprehensive study of VDCs in Ngamiland showed that they are well appreciated and highly regarded by village communities as legitimate representation, which allows communities to contribute directly to district development planning. In addition, they enable community members to publicly hold government officials accountable (Ngwenya, 2008). However, VDCs in the study villages still have limited impact on the control of natural resources, their role being mainly confined to infrastructural and social development. Even in infrastructural and social development, they are confined to areas within their own villages. For instance there is still no forum for discussing matters pertaining to inter-village development. Villages can only take those to the district council, or a related sectoral department of central government, through their councillors[6]. In other words the structure for addressing such issues is still vertical without horizontal linkages. VDCs have limited financial and human resources, and depend on local government funding for all major projects.

The parents and teachers' association is another committee that enjoys more support and almost the same explanations were given. It serves the interests of most community members who have keen interest in their children's education. However, the members of this committee do not receive any allowances, its role is not that of an umbrella committee and it does not enjoy the same status in the village as does the VDC.

[6] Councillors are community political representatives at the district council.

Households were also asked to state whether they know of any cultural rules used in the allocation of wells and further probed on whether they knew of any rules for the management of water resources in their area. This was meant to capture local or indigenous knowledge and informal rules useful for water resources management. The results show that 84.9% stated that there were no such rules while 13% indicated that there were rules for the allocation of hand dug wells in the study villages.

That most households in this study do not know of any rules is not understandable since it is suggested in some literature that cultural rules for control of resources and land allocation existed before the creation of modern institutions (Schapera, 1970; Zuffrey, 1983). Some households stated cultural rules regarding water use particularly in Kedia and Khumaga in the lower sub-Basin.

In Kedia, these include consultation among neighbours, allocation by traditional leaders, and what others termed "owners of the land" who are mainly water diviners who have to be consulted for the proper location of the wells and perform some ritual before excavation could be done. Water divining or dowsing is usually used mostly in arid environments where there is general lack of modern technology to locate groundwater or where such technology proves widely unaffordable (Kgathi *et al.*, 2004). The finding on water diviners is an intriguing one since Kgathi *et al.* (2004) also found this activity quite attractive to some locals as well as some non-indigenous residents of the Okavango Delta.

In Khumaga households indicated that one can only dig a well in the river within an area that coincides with extent of their *molapo* field. That is, one cannot dig a well anywhere

beyond the area where their field is located. These informal rules apply though they are not recognized by the land board which now issues permits for hand dug wells. There is also the strong cultural notion that water for immediate personal or domestic use should be availed to all free of charge since water is a natural "gift from God". These unwritten norms and rules are useful in water management since they play a greater role in the way communities would perceive new management practices.

In order to determine level of awareness and general willingness to participate, households were asked to mention any water management authority in their area, state who they think should manage water resources and why. Most households (85.1%) indicated that they know the district council as the main water authority and an important stakeholder in water management in their area. Household opinion on who should manage water resources was widespread, many of them, as shown in Figure 12 below, indicating that district council should manage water resources in partnership with communities.

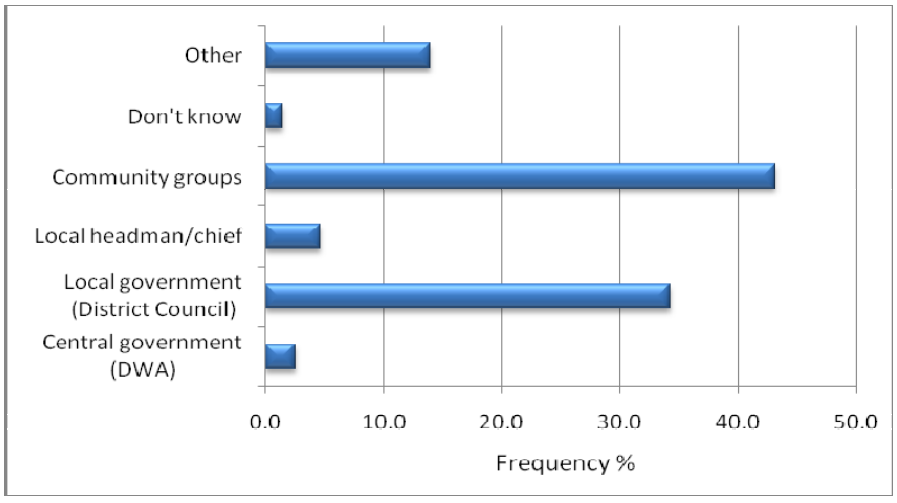

Figure 12: Household perceptions on water management institutions in the study villages

In proportional terms, 43.2% of households felt the community should manage water resources while 34.3% stated that local government should play major role in water resources management. The rest of the households in the study villages stated that central government (2.5%), traditional leaders (4.6%), while some stated that they "do not know" (15.3%). Opinions on why communities want to be involved were that, community members are the main users and they are mostly the inhabitants of areas where the resource is found, and on the other hand, the district council has financial resources and capacity to manage water resources. Generally, community participation is possible through existing local institutions and communities in the Boteti River sub-Basin are willing to participate in the management of water resources in their area. Perhaps the approach used under the community-based natural resources management (CBNRM), mostly used for wildlife-based tourism and veld products collection, can be tested at another level to include other natural resources including water. Water management that includes communities may be more in the form of devolved responsibility for operation and maintenance, greater consultation, direct contribution to decision making, and wise use (SMEC, 1991).

CHAPTER 5: CONCLUSION

5.1 INTRODUCTION

The aim of this study, as earlier stated, was to investigate the socio-economic characteristics of the Boteti River sub-Basin with a view to determining the potential for developing integrated management of water and land resources in the sub-Basin. This chapter summarises the results of the study in relation to the stated objectives and hypotheses and makes conclusions and recommendations under the sub-headings, "Key livelihoods in the Boteti river sub-Basin", "Water use types and patterns", "Water management institutions" and concludes with summary section.

5.2 KEY LIVELIHOODS IN THE BOTETI RIVER SUB-BASIN

The key livelihoods identified in this study are dryland arable farming and livestock farming being undertaken by 62.5% and 58.4% of all households, respectively. These are also considered by households, in the study villages, as the most important. An assessment of these livelihoods indicates that they are undertaken, on a subsistence basis, together with others such as government assistance, drought relief/labour-intensive-public-works, formal and informal employment, *molapo* farming, small business, beer brewing for sale, remittances and veld products collection.

Though subsistence dryland arable farming and livestock rearing support the lives of the majority of the sub-Basin inhabitants, they do not contribute enough to lift most households out of poverty given the harsh bio-physical conditions of frequent droughts, drying of the river and the incidence of animal and human diseases. However these are

the main livelihood earners in the study villages and by extension the entire Boteti River sub-Basin.

In this study, Objective 1 has been achieved since the key livelihoods have been identified and assessed. However, the impact of livelihood shocks (such as drought, diseases and drying of the river) may require further investigation to identify livelihood portfolios that can reduce vulnerability and improve living levels among communities.

5.3 WATER USE TYPES AND PATTERNS

The main water use types identified among households in the study villages are livestock watering and domestic use. Other uses include molapo farming, gardening, and subsistence fishing and small scale commercial fishing.

Most households (95.2%) in the upper sub-Basin villages of Chanoga and Makalamabedi use surface water for their livestock while all those in Khumaga and Kedia, in the mid and lower sub-Basin respectively, use groundwater mainly from hand dug wells. Hand dug wells are mostly acquired by self allocation and developed by households themselves. The land board does not allocate hand dug wells, in the river bed, but has only recently shown interest in registering them to control their proliferation. There is potential for self regulation among owners since households consider hand dug to be potentially dangerous during flooding.

Water for domestic use is mainly obtained from the village water reticulation system in all the study villages. Only few households (0.6%) use other sources such as hand dug wells and, in the upper sub-Basin, direct collection from the river. This means that the

village water supply system is the most important water source for households in the Boteti River sub-Basin. Households have also indicated that they use mainly grey water, from bathing and washing of clothes, for home construction. This shows household willingness to make full use of available water to reduce the burden of obtaining more water from the water source.

Village water supply systems are faced with challenges that reflect lack of sense of ownership of these facilities within the study communities. These challenges include vandalism, culprits being rarely identified, and frequent damage by livestock. These occur though there are people employed by district council to take care of the public water taps. While this reflects lack of commitment to protect this important source of potable water it also highlights a need to use water for other purposes in addition to domestic use. It also reflects on current water management practices where the water authorities just develop infrastructure, provide the much needed water and communities are passive recipients of these services.

The study has identified livestock watering and domestic use as the main water uses among households or communities in the Boteti River sub-basin. The water use patterns for these two uses have been assessed. Therefore, Objective ii (to identify and assess types and use patterns of water resources in the Boteti River sub-Basin) has been achieved. However, water use types and patterns for other water users (than households or communities) may require further research. The findings on the proliferation of hand dug wells and the challenges to water reticulation systems have confirmed Hypothesis 1 (Current management practices contribute to general environmental degradation in the sub-Basin.) The study has also shown that there is potential for self regulation among

hand dug well owners, and that there is grey water re-use among households in the study villages. These results have partially confirmed Hypothesis 2 (Residents of the sub-Basin have the willingness and capacity to manage their resources) showing there is willingness, among households or community members, to manage water resources in their area.

The above results have achieved the objectives and the hypothesis have been also been reasonably confirmed. It can therefore be concluded that surface water is an important source of water for livestock in the upper sub-Basin while groundwater is an important water source in the mid- and lower sub-Basin. All management initiatives need to accommodate these spatial differences. Decisions on water management in the Boteti River sub-Basin need to consider the importance of hand dug wells to small farmers, especially in the mid- and lower sub-Basin. The potential for self regulation among hand dug well owners provides a crucial entry point for community involvement in integrated water resources management in the Boteti River sub-Basin. Water for livestock is the responsibility of individual livestock owners while water for domestic use is provided by the district council. It can therefore be concluded that households or residents of the Boteti River sub-Basin are more willing to manage water resources when they are directly responsible for obtaining and developing ways and means for utilising them.

5.4 PARTICIPATION AND WATER MANAGEMENT INSTITUTIONS

The district council supplies rural villages at very high cost with limited cost recovery. Public water taps supply free water to communities and for private water connections there is poor collection of water fees. Because of the high cost of supply and limited cost recovery, district councils have limited capacity to provide a consistent supply of clean

potable water to communities. This is not helped by lack of direct community involvement in the protection and proper use of public stand pipes as shown here and in the above section. The case of Makalamabedi (Central) shows that water management that fails to recognise the fugitive nature of resources can also result in higher expenditure. Though it was reasonable to supply both villages of Makalamabedi from one water source, the administrative arrangements fail to take advantage of the available opportunity to minimise the costs of water supply. A more regional and sectoral approach with predominantly vertical lines of control and response without any horizontal linkages also makes the above challenges worse.

At the level of local communities, the village development committee (VDC) has been identified as the most important and well known community development organization in all the study villages. It enjoys the most support as it is regarded as being close to the community, leads village development and that its members are paid allowances that serve as incentives for active participation. The closeness to the community indicates that it serves most people's interests and it may serve as an entry point for developing integrated management of water resources in the study villages. VDCs can help mobilize and encourage community members to support IWRM initiatives. This is however, not without challenges since these committees are generally overburdened with many functions. They also do not have enough financial resources to run major projects including capacity building either within the committee itself or in the community.

The study has found that most community members do not know other committees, such as the Farmers' Committee, in an area where the main livelihood sources are farm rather than non-farm based activities. This is an indicator of low participation by households in

the organised facilitation of service provision in all the villages. However, some communities still maintain an appreciable level of community participation to deal with some pressing challenges. An active conservation committee in Chanoga has shown initiative in mobilising and organising the community towards community-based natural resources management. The committee is also working to curb water pollution in the river.

The results of the study also indicate that most households do not know any cultural rules for the management of water and other resources in their area. This is an indication that there are no major cultural barriers to change among communities in the study villages. Even among those households that mentioned some rules, these support wise use. For instance, in Kedia and Khumaga some households have mentioned rules that promote or show inherent understanding of wise use and the ability for self regulation based on culture among the residents. The belief that water should be free for all will ultimately change with the introduction of pre-paid water cards as mentioned in sub-section 4.4.2.2.

As shown in this section the district councils, as the main water management authority in rural villages, are faced with the challenges of maintaining and sustaining clean potable water for communities in the Boteti River sub-Basin. Some of the challenges reveal the duplication of efforts caused by inherent separation of control within the same system, *i.e.* two districts under one ministry managing one resource. Objective iii (to examine the institutions involved in the management of water resources in the sub-Basin) has been achieved. However, more research on legal and policy aspects needs to done in the study area. The study could not cover institutions relating to most land resources and these may require further investigation. This section has also shown community willingness and

limited capacity to manage resources confirming Hypothesis 2, of course with slight modification. Communities in the study villages are generally willing to manage resources in their area.

5.5 SUMMARY

This study shows that the Boteti River sub-Basin is largely dominated by communal livestock rearing and arable farming. These livelihoods are combined, in an important subsistence package, with government assistance, drought relief/labour-intensive-public-works, formal and informal employment, *molapo* farming, small business, beer brewing for sale, remittances and veld products collection. Other socio-economic activities of great importance to water management, in the sub-Basin (though not the focus of this study) are diamond mining mainly in the town of Orapa, wildlife management and tourism in the two conservation areas of the Central Kalahari Game Reserve and the Makgadikgadi Pans National Park, livestock ranching, and the service-based commercial and industrial activities in the urban villages of Maun and Letlhakane. The main link between all these human activities is groundwater resources since the river has not had much surface water for nearly two decades. A livelihood approach to integrated water resources management in the sub-Basin will be more appropriate to help improve livelihoods and address the related environmental challenges. This will be the way forward towards developing integrated management of the ephemeral Boteti River sub-Basin and by extension other ephemeral river basins in Botswana.

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APPENDIX: HOUSEHOLD QUESTIONNAIRE

A. DEMOGRAPHIC INFORMATION

List of all household members

Name	**1) Gender**	**Age/DoB**	**2) Marital status**	**3) Educational level attained**	**4) Ethnicity**
i.					
ii.					
iii.					
Codes	1. Male 2. Female	Years	1. Married 2. Divorced 3. Widowed 4.Cohabitation/ living together 5. Single/never married 6. Other (specify)……..	1. None 2. Primary 3. Junior secondary 4. Senior secondary 5. Tertiary 6. Other (specify) ……	1. Monambjwa 2. Kalanga 3. MoSarwa 4. Wayeyi 5. MoKgalagadi 6. MoMbukushu 7. MoTawana 8. MoNgwato 9. Other (specify)……

	5) Religion	**6) Relationship to head of hhd**	**7)** Whether employed	**8) Occupation**	**9) Employment status**	**10) Living here?**	**11) If No, to Q10 where?**
i.							
ii.							
iii.							
Codes	1. Christian 2. Moslem 3. Traditional 4. Other (specify)……	1.Head 2.Wife/husband/partner 3.Son/daughter 4.Father/mother 5.Grandchild 6.Brother/sister 7.Brother/sister-in-law 8.Other relative 9. Not related	1. Yes 2. No	**1.Professional eg. teaching, nursing** **2.Clerks,service,sales eg. Stores/shop attendt** **3.Craft/related trade eg. handcrafting** **4.Plant/machine operators eg. drivers** **5.Elementary occupns eg.cleaner, gate keeper** **6.Other (specify…….. ……**	1. Full time 2. Part time 3. Seasonal	1. Yes 2. No	Place of stay

Other household characteristics

Question	Response	Code
12) Type of household head.	1. Defacto female headed *(husband/male head away)* 2. Dejure female headed *(widowed, never married)* 3. Male headed	___
Type of housing structure	1. Mainly traditional in good repair 2. Mainly traditional in poor repair 3. Mix of both types good repair 4. Mix of both types poor repair 5. Modern corrugated roof good repair 6. Modern corrugated roof poor repair 7. Other (specify)……..	1.___ 2.___ 3.___ 4.___ 5.___ 6.___ 7.___
13) What form of energy does this household use for the following purposes?		
(i) Lighting	1. Candle 2. Paraffin lamb 3. Fire wood 4. Solar energy (panels) 5. Electricity 6. Both candle and paraffin 7. Other (specify)……	___ ___ ___
(ii) Cooking	1. Paraffin 2. Fire wood 3. Gas 4. Electricity 5. Both firewood and gas 6. Other (specify)……	1.___ 2.___ 3.___ 4.___ 5.___ 6.___

B. TYPES OF LIVELIHOOD ACTIVITIES

Question	Response	Code
14) Indicate all livelihood activities that your household is engaged in. *(please use* X in code box)	1. Livestock farming 2. Dryland arable farming 3. Molapo arable farming 4. Formal employment 5. Informal employment including "piece-jobs" 6. Beer brewing for sale 7. Veld products collection for sale 8. Thatch grass harvesting for sale 9. Remittances 10. Government assistance/social welfare programs 11. Drought relief/LIPW employment 12. Small business enterprise 13. Medium to large business enterprise 14. Other (specify)……..… ……..…… ……..	1.___ 2.___ 3.___ 4.___ 5.___ 6.___ 7.___ 8.___ 9.___ 10.___ 11.___ 12.___ 13.___ 14.___
15) Please name four major sources livelihood for your household, in order of importance: **1** being most important, **4** being least important	1. Livestock farming 2. Arable farming 3. Formal employment 4. Informal employment 5. Beer brewing 6. Veld products 7. Thatch grass harvesting 8. Remittances 9. Government assistance/social welfare programs 10.Drought relief/LIPW employment 11. Small business enterprise 12. Donations from relatives 13. Other (specify)…… ……	1.___ 2.___ 3.___ 4.___ 5.___ 6.___ 7.___ 8.___ 9.___ 10.___ 11.___ 12.___ 13.___
16) How many people in your household are engaged in the following activities? *NB: Guided by responses to Qs 14 & 15 (Write number of people in code box)*)	1. Livestock farming 2. Dryland arable farming 3. Molapo arable farming 4. Formal employment 5. Informal employment including "piece-jobs" 6. Beer brewing for sale 7. Veld products collection for sale 8. Thatch grass harvesting for sale	1.___ 2.___ 3.___ 4.___ 5.___ 6.___ 7.___ 8.___

	9. Remittances 10. Government assistance/social welfare programs 11. Drought relief/LIPW employment 12. Small business enterprise 13. Medium to large business enterprise 14. Other (specify)……..…….…… ……..…… ……..	9.___ 10.___ 11.___ 12.___ 13.___ 14.___

17) Does your household own any of the following types of livestock? (*Tick as applies)*

	1. Yes	2. No	Number
(i) Cattle			
(ii) Goats			
(iii) Sheep			
(iv) Donkeys			
(v) Horses			
(vi) Poultry			
(vii) Other (specify)			

18) Where are these kept? ***[Enumerator: please indicate type of livestock and where kept]***	1. In the village 2. Outside the village 3. Cattle post 4. Lands area 5. Ranch/farm 6. Other (specify)……	___ ___ ___
19) How far is this place from the….	1. Village……km 2. River……km	

20) Does your household own any of the following arable field types?		
1. Molapo field	1. Yes 2. No	___
2. Dryland field away from the river	1. Yes 2. No	___
3. Horticultural garden	1. Yes 2. No	___
4. Other (specify)……. ……..	1. Yes 2. No	___

C. TYPES AND PATTERNS OF USE OF WATER

21) For what purposes do you use the Boteti River water?		
i) Domestic use	1. Yes 2. No	___
ii) Water livestock	1. Yes 2. No	___
iii) Arable farming	1. Yes 2. No	___
iv) Brick moulding	1. Yes 2. No	___
v) Vegetable garden	1. Yes 2. No	___
vi) Other (specify)……. ……	1. Yes 2. No	___

DOMESTIC WATER USE PATTERNS

22) Where do you obtain water for the following uses:		
i) Drinking, cooking etc	1. Public stand pipe 2. Tap in the yard/in-house>>Q22ii 3. Hand dug well 4. River 5. Pool 6. Other (specify)……... ……..	___
ii) Washing clothes/bathing	1.Public stand pipe 2.Tap in the yard/in-house>>Q22iii 3.Hand dug well 4.River 5.Pool 6.Other (specify)……... ……..	___
iii) Home construction	1. Public stand pipe 2. Tap in the yard/in-house>>Q23 3. Hand dug well 4. River 5. Pool 6. Other (specify)……... ……..	___

23) Generally, who collects water for domestic use?	1. Men 2. Women 3. Both men and women 4. Male children 5. Female children 6. Both male and female children 7. Women and children 8. All household members 9. Other (specify)……..	___ ___ ___
24) Who decides how water should be used in the household?	1. Men 2. Women 3. Both men and women 4. Other (specify)……..	___ ___ ___
25) How much water per day do you use for the following purposes…..**..** ***NB: Use 20 litre container as standard. Only per day rate required***	**i)** Drinking, cooking etc	……..Litres
	ii) Washing clothes/bathing	……..Litres
	iii) Home construction	……..Litres
	iv) Other (specify)	……..Litres
26) How do you obtain water from the source(s) stated in **Q22** above? ***NB: Go to Q28 if answer to Q22 is 2***		
i) Public stand pipe	1. Head bucket/other hand held container 2. Roll-over tank/wheel burrow 3. Donkey cart 4. Motor vehicle 5. Other (specify……	___ ___
ii) Hand dug well	1. Head bucket/other hand held container 2. Roll-over tank/wheel burrow 3. Donkey cart 4. Motor vehicle 5. Other (specify……	___ ___
iii) River	1. Head bucket/other hand held container 2. Roll-over tank/wheel burrow 3. Donkey cart 4. Motor vehicle 5. Other (specify……	___ ___
iv) Pool	1. Head bucket/other hand held container 2. Roll-over tank/wheel burrow 3. Donkey cart 4. Motor vehicle 5. Other (specify……	___ ___
v) Other (specify)……	1. Head bucket/other hand held container 2. Roll-over tank/wheel burrow 3. Donkey cart 4. Motor vehicle 5. Other (specify……	___ ___
27) How far is (are) the source(s) stated in **Q22** above from the household?	**i)** Public stand pipe	……km
	ii) Hand dug well	……km
	iii) River	……km
	iv) Pool	……km
	v) Other (specify)…….	……km
28) Generally who maintains the following water sources in your village? i) Public standpipe and borehole supplying village …… ii) Private/in-house water tap…… iii) Hand dug well …… iv) Other (specify)……		
29) Please indicate your personal opinion about <u>public stand pipes</u> in your village by choosing appropriate option to the statements below ***[Options: 1. Strongly agree 2.* Agree *3. Neither agree nor disagree 4. Disagree 5. Strongly disagree]***		
i) They are generally vandalised and culprits are rarely identified		___
ii) Some community members water their livestock during the night		___

iii) Livestock frequently damage them	___
iv) There is generally no monitoring to ensure proper use	___

30) As a community member and beneficiary of services provided by public stand pipes, express your opinion on how these challenges could be overcome.....

LIVESTOCK WATER USE PATTERNS (If no livestock >> Section D)

31) Where do you obtain water for the following types of livestock?
i) Goats/sheep etc.……
ii) Donkeys……
iii) Cattle……
iv) Horses……..
v) Other (specify)……..

32) Explain, if any type of livestock is watered at a different location from the other(s)……
……
……
……
……

33) How long does it take to water your livestock?.....
……..
……..

34) How often do you water your livestock in the following seasons? *(Pls. indicate type of livestock)*

Type of livestock	**Winter**	Summer
i) Goats/sheep		
ii) Donkeys		
iii) Cattle		
iv) Horses		
v) Other (Specify)…….		

Codes Q31:
1. Once a day
2. Once in 2 days
3. Twice daily
4. Other (specify)…….

35) Do you own a hand dug well?	1. Yes 2. No	___
36) If "Yes" to **Q35,** how was this well allocated?	1. Self allocation 2. Allocated by relative/friend 3. Allocated by the chief/headman 4. Allocated by Land Board 5. Other	___
37) If "No" to **Q35,** whose hand dug well do you use to water your livestock? ***NB: Enumerator, please consider answer to Q31***	1. Relative 2. Friend 3. Neighbour 4. Other (specify)……..	___
38) Do you know of any cultural/traditional rules that control the allocation of hand dug wells in your area?	1. Yes 2. No	___

39) If "Yes" to **Q38** please mention the rules and how they were applied ……
……
……
……
……

40) Are there any problems relating to the watering of livestock in your area?	1. Yes 2. No	___

41) If "Yes" to **Q40** what are the problems…… ……
……
……
……
……

42) Does livestock watering affect other water users in your area?	1. Yes 2. No	___

43) If "Yes" to **Q42** how is the watering of livestock affecting other water users in your area?
…… ……
……

…… …… ……
44) Are there any problems relating predation of livestock by wildlife in your area? Please explain…… ……

D. WATER MANAGEMENT INSTITUTIONS

45) Are there any committees, institutions, organisations that exist in your village? ***NB: Please indicate with X those named by respondent***	1. Village development committee 2. Conservation committee 3. Water committee 4. Farmers' committee 5. Village health committee 6. Crime prevention committee 7. Youth committee 8. Women's organisation 9. Borehole syndicate 10. Community trust 11. Business cooperatives 13. Community projects for fundraising 14. Drift fence committee 15. Religious organisations 16. Cultural organisations 17. Other (specify)…… …… …… ……	1.___ 2.___ 3.___ 4.___ 5.___ 6.___ 7.___ 8.___ 9.___ 10.___ 11.___ 12.___ 13.___ 14.___ 15.___ 16.___ 17.___
46) Are you a member of any of these committees, institutions, organisations?	1. Yes 2. No	__
If "Yes" to **Q46, to** which one(s) are you a member? ***NB: Please write the name or list number as in Q45*** …… …… ……		
47) If "NO" to **Q46** why? …… …… …… ……		
48) Is any member of your household a member of any of these committees, institutions, organisations?	1. Yes 2. No	__
49) If "NO" to **Q48** why? …… …… …… ……		
50) Which of these committees enjoy the most support in the village? ***NB: Please write the name or list number as in Q45*** …… …… ……		
51) In your opinion why does this (these) committee(s) enjoy the most support?…… …… …… ……		
52) Are there any group(s) of people who have combined efforts to obtain or dig a well or borehole to use as a group in your area?	1. Yes 2. No	__
53) Who is in charge of managing water resources in your area?	1. Central government (DWA) 2. Local government (District Council) 3. Local headman/chiefs 4. Community groups 5. Other (specify)…….. …… …… ……..	__
54) In your opinion who should manage water resources in your area?	1. Central government (DWA) 2. Local government (District Council) 3. Local headman/chiefs 4. Community groups	__

	5. Other (specify)…….. ……..…… ……..…… ……..	
i) Please mention why?..... …… …… ……		
ii) How do you think this can be done? ..... …… …… …… ……		
55) In the past has there been established ways of managing water resources in your area?	1. Yes 2. No	—
56) How were the water resources managed in your area? ..... …… …… …… …… ……..		
57) Is the Boteti River managed differently now than in the past?	1. Yes 2. No	—
58) If "Yes" to Q57, how was it managed in the past? ……... …… …… …… ……..		
59) Does upstream water use in the Boteti River affect water availability in your area?	1. Yes 2. No	—
60) If "Yes" to **Q59**, how does upstream water use affect water availability in your area? …… …… …… ……		
64) Closing comments: Are there any other issues of water use and management we have not discussed? Please feel free to give final comments…… …… ……		