Okavango River Basin Transboundary Diagnostic Analysis Technical Report

OKACOM

The Permanent Okavango River Basin Water Commission

Okavango River Basin Trans-Boundary Diagnostic Assessment (TDA): Botswana Component Out Put 5: Socio-Economic Profile

G. Mmopelwa

July 2009

Environmental protection and sustainable management of the Okavango River Basin

EPSMO

SOCIOECONOMIC SERIES

OutPut 5:

Socio-Economic Profile

G. Mmopelwa

7/30/2009

Contents

LIST OF FIGURES

LIST OF TABLES

Executive Summary

This report contains three sections. The first section is a review of literature to estimate, per representative social area within Botswana, continent value of each major river-related resource used and its importance in people's lives in terms of poverty alleviation. The second section is an assessment of livelihoods and reliance on river (and associated resources) for household income for representative social areas within Botswana portion of the Okavango River Basin is done. The third section deals with assessing food security and nutrition value associated with river and associated resources within each representative social area

The Okavango Delta resources in northern Botswana form the basis of livelihoods for many of the communities, many of whom are poor. Studies have been carried out to estimate gross and household private values for resources and livelihoods in the Panhandle, south west, south east and central part of the Okavango Delta.

Livestock farming is one of the most important livelihood activities. Livestock, especially cattle, is kept at cattle posts and villages. The total estimated household net private value for livestock keeping at the cattle-post and villages were BWP54.5 million and 6.6 million, respectively. The value of cattle keeping was highest in the western part and lowest in the southern part of the Delta.

There are two types of arable farming systems; flood recession agriculture and reinfed agriculture. The average size of area cultivated for both systems is 2.1 hectares. The total household net private value for flood recession was estimated at BWP2.2 million, with the highest value occurring in the western part and the lowest occurring in the Panhandle.

Subsistence/traditional, commercial and recreational fishing are also important economic activities. The turnover for subsistence and commercial fishing has been estimated at BWP1.5 million. The preferred subsistence and commercial fish species are *Oreochromis spp*, *Serranochromis spp, Hydrocynus vittatus,* while bream and the tiger fish (*Hydrocynus vittatus*) are the preferred species for recreational fishing. The total net private value of traditional fishery and gillnet fishery were estimated at BWP657 883 and BWP1031, respectively. The net household private value of traditional fishery was highest in the Panhandle, while that for gillnet fishery was highest in the central part of the Delta.

Communities in the Delta harvest a number of plants and/or their products which they utilize in diverse ways. These include river reed, grass, palm leaves, papyrus, poles, timber, fuelwood, wild foods and vegetables and medicinal plants. The total household net private value of river reed was estimated at BWP2 252 361, and the highest net household private value was recorded in the south east, while the smallest was recorded in the central part of the Delta. The total household net private value of grass was estimated at BWP3 087 761. The highest net private value of grass was highest in the Panhandle. Palm leaves were estimated to have a total net household private value of BWP1 787 837. The highest net private values were recorded in the Panhandle.

The values of poles, timber and fuelwood were estimated at BWP1 681 222, BWP568 697 BWP8 581 022, respectively. The net household private value of poles was highest in the south west, while the highest for timber and fuelwood was recorded in the Panhandle and west of the Delta, respectively.

Wetland foods were estimated to have a total net household private value of BWP 99 207. The highest net household private value was recorded in the Panhandle, while the smallest was recorded in the south east of the Delta. The total household net private value for medicinal plants was estimated at BWP277 729.8. The highest household value of medicinal plants was in the western part, while the smallest was in the central part of the Delta.

The Delta also supports a large tourism industry in various ways, including wildlife viewing, safari hunting, canoe rides, site-seeing, motor boat cruises, and recreational fishing. The gross (direct) output of tourism in the Okavango Delta Ramsar site was estimated at BWP1115.8 million, and the gross value added was estimated at BWP 401 million. Using an estimated 40-50 000 tourists visiting Moremi Game Reserve annually, consumer surplus accruing wildlife viewing have been estimated to be between USA$ 9.4 million to 11.8 million.

The sustainable livelihood framework was used to assess livelihoods in the Okavango Delta. Five different forms of capital are recognized, and these are natural, physical, financial, human and social capital. Natural capital includes a wide range of natural resources harvested from the Delta which include vegetation and its products, water and fishing. The first level of stakeholders who derive livelihoods from natural capital, (who are mostly the poor) are vulnerable to shocks such as drought and changes in flooding, because they lack alternative means of living.

One of the common and very important physical capital in the Delta is the use of cattle as source of drought power. Other forms of physical capital include storage facilities for fishers. Most fishers lack adequate and good storage facilities. They also lack the means of transporting their catch to other market outlets.

Family labour, as opposed to hired labour, is a common form of human capital in households' pursuance of various livelihoods. Another important, but less recognized form of human capital is indigenous knowledge possessed by fishers. This knowledge is used by fishers in the sustainable utilization of fish. Centralized fisheries management, driven by government policy has tended to ignore this knowledge and emphasize top-down management.

Most famers lack financial capital, and are too poor to access credit. While the distribution of cattle is skewed, farmers who own cattle convert them to the needed cash.

Social capital is found in the form of community trusts, fishing syndicates and farmers associations. These networks enable members to benefit from programmes that may be financially supported by government.

In pursuit of livelihoods, households combine two or more different activities to spread risk. Activities that are often combined include arable farming, livestock farming, fishing, basket making, and community based tourism. Activities such as fishing and flood recession agriculture can be adversely affected by changes in flood. Assets such as cattle are affected by drought and disease outbreaks (e.g. Food and Mouth and lung disease), while tourism can be affected by factors such as political instability, market changes and local and international policies.

Assessment of food security in this study was based on considering efforts by government and households to ensure food security at household level. Food security refers to a condition when all people, at all times, have physical and economic access to sufficient, safe and nutritious food at the individual or household level. Poor people are more likely to be food insecure because they lack access to sufficient food. In the past, the government of Botswana instituted social safety net programs as an acknowledgement that poverty is widespread in rural areas. These

programmes include home based care, school feeding, old age pension and drought relief. While the contribution of social safety net programs to poverty alleviation is significant, there has been a general lack of understanding of the critical role of natural safety nets in food security. Natural resources are source of a variety of food that supplement and complement what is normally consumed at the household level. Their direct contribution to food security is through their supply, (e.g. subsistence utilization), while their indirect contribution is revenue generation. For instance, green leafy vegetables harvested during the rainy season and high flood season and tubers (*Nymphaeas* family) harvested during low flood season in the Panhandle, contribute to nutrition security as well as dietary diversity for most of poor households. Thus, these products provide a critical safety net function for the riparian households as they become as source of food during emergency period such as drought, famines, floods and sickness and thereby reduce household risk and vulnerability to falling deeper into poverty.

1. CONTINGENT VALUE OF EACH MAJOR RIVE RELATED RESOURCE USED AND ITS IMPORTANCE ON IN PEOPLE'S LIVES IN TERMS OF POVERTY ALLEVIATION

1.1 Introduction

Worldwide, wetlands are prone to loss and degradation because their values (especially functional values) are not understood, or where these values are understood, they are simply not appreciated (Winpeny, 1991). They are also often considered wastelands, unproductive and without value (Turner *et al.,* 2000; Silvius, 2000). Most of their products are also not marketed, making them appear to have low economic values which in turn leads to inefficient resource allocation (Daily *et al.,* 1997). Wetlands also have characteristics of public goods, implying that the services they provide are not paid for by the users- people do not want to pay for things which do not belong to any private body (Barbier *et al.,* 1997; Daily *et al.,* 1997). Further, wetlands are in many cases open access resources where no rules apply to their use, hence are often subjected to over-exploitation. This market failure is considered one of the most important causes of wetland conversion and loss (Turner *et al.,* 2000; Barbier *et al.,* 1997; Daily *et al.,* 1997).

The Okavango Delta wetland holds the largest freshwater reserves of the country and supports the livelihood of many communities, many of whom are poor (Gumbricht *et al.,* 2004; Ashton et al., 2003; Silvius *et al.,* 2000; Rothert, 1997; Neme, 1997). The poor are generally those who lack adequate food and shelter, education and health, face extreme vulnerability to ill-heath, economic dislocations and natural disasters and often exposed to ill treatment by institutions of the state and are powerless in influencing key decisions affecting their life (World Bank, 2000).

Like most other wetlands, the Okavango Delta provides a variety of goods and services to communities living in and around it. Estimating the economic value of these goods and services is extremely important for the sensitization of policy makers on the need to plan for the conservation and sustainable utilization of the Delta's resources. Economic valuation of river based resources also presents the use value of these resources to those who are income poor and depending on these resources.

The total economic value framework (Figure 1) is often used to present various values of resources (Pearce and Turner 1990; Adger *et al.,* 1994). The total economic value is an aggregate of direct use value (benefits that arise from people's direct use of the resource), indirect use values (benefits derived from services that the environment provides, and do not require any good to be harvested, nor do they enter a market at all), option value (the willingness to pay for an environmental resource arising from the fact that an individual values an environmental resource because he/she has the option to use that resource in the future), existence value (value attached to knowing that an environmental asset exists even though the value attributer may not be interested in consuming that resource) and bequest value (value that an individual derives from ensuring that the resources will be available future generations).

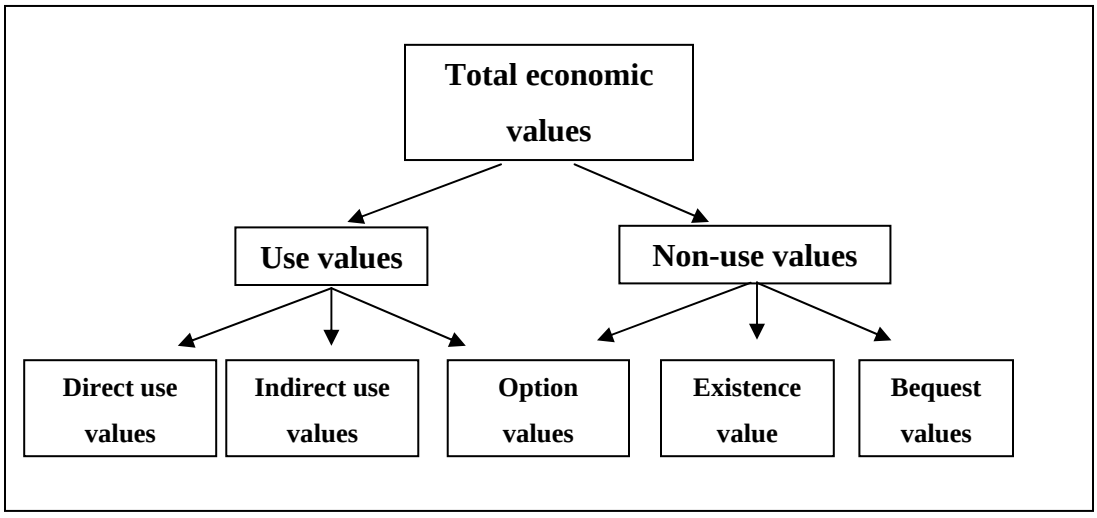

Figure 1: Total economic value framework for wetlands

1.2 Value of resources

1.2.1 Livestock and crop farming

Livestock keeping is one the most important livelihood activities in Okavango Delta (Turpie *et al.,* 2006). Livestock comprises cattle, goats, sheep, donkeys and horses. Cattle are used as source of income, meat, draught power and milk; goats and sheep are also used as source of meat and income; while donkeys are a source of draught power (pulling scot carts and ploughing). Horses are predominantly used for transport (riding).

Livestock is often kept at cattle post and at villages. In five study areas of Panhandle, west, south west, south east and central of the Okavango Delta, Turpie *et al.* (2006) found that the average number of cattle kept per household at the cattle posts and villages was 38 and less than 5, respectively. The total number of large stock unit in the study areas was estimated at 655 000. The total estimated net household net private value of livestock kept at cattle posts and villages was BWP54,5 million and BWP6, 6 million, respectively (Turpie *et al.,* 2006). Figure 2 shows that the net private value per household of livestock farming in cattle post was highest in the western part of the Delta, while the highest value of livestock farming in villages occurred in the south western part of the Delta. Due to the fact that cattle owners usually do not reveal the actual number of livestock they have, these values may be considered underestimates.

Arable farming is another important livelihood activity in the Okavango Delta. In the Panhandle, west, south west, south east and central of the Okavango Delta, 47% of the households practiced dryland farming, while 28% practiced flood recession farming, locally known as *molapo* farming (Turpie *et al.,* 2006). The size of area cultivated for both systems is quite small, averaging 2.1 ha per household. Dryland farming is practiced around Etsha villages by the Hambukushu ethnic group. *Molapo* farming is practiced in the flood plains mostly by the Bayei and the Batawana (Bendsen and Meyer, 2003). The total household net private value for flood recession farming in the Panhandle, west, south west, south east and central of the Okavango Delta was estimated at about BWP2.2 million (Turpie *et al.,* 2006) Figure 2 indicates that the

highest net private value per household of *molapo* farming occurred in the western part of the Delta, while the smallest occurred in the Panhandle where there are no floodplains.

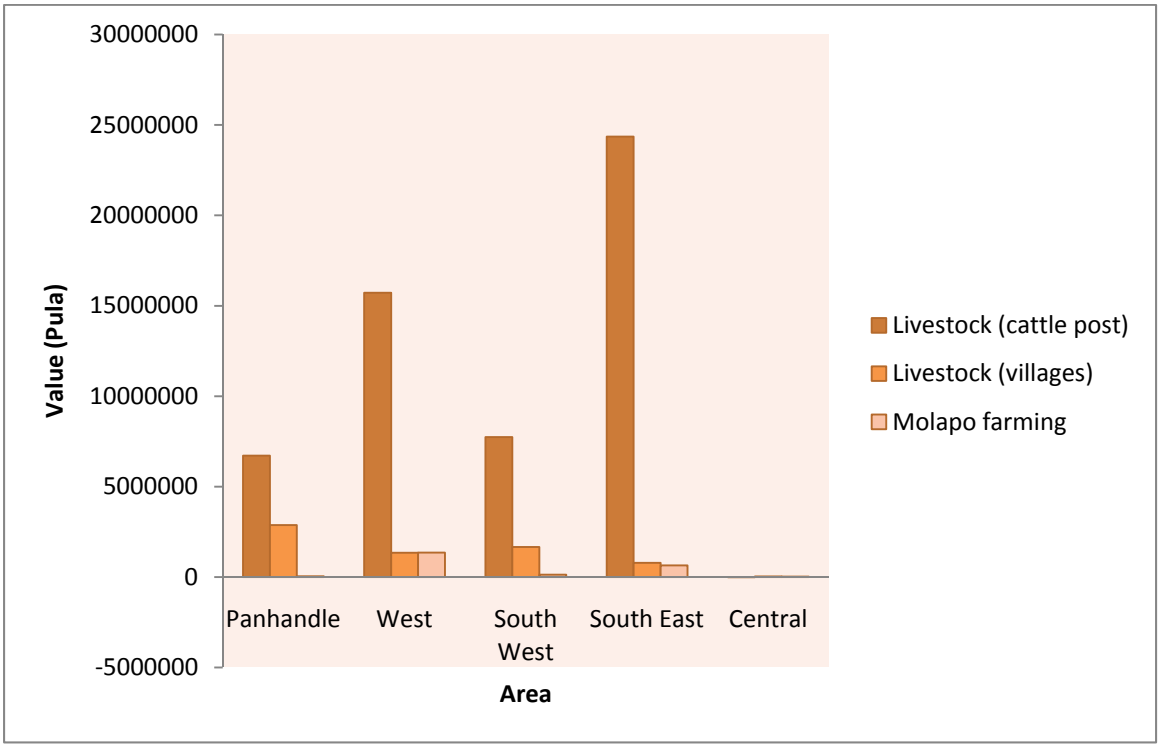

Figure 2: Household net private value (BWP) for livestock and crop farming in different areas of the Delta (2005 prices) (Source: Turpie et al., 2006)

1.2.2 Fishing

Subsistence, commercial and recreational or sport fishing are common in the Delta (Mmopelwa et al., 2005). According to Mosepele (2001), 65% of the Ngamiland north population depends on fishing and that the total annual economic turnover in the Okavango fishery is approximately BWP1.5 million. However, the number of fishers varies widely for the reason that there are occasional fishers whose individual time spent on fishing is low, and who, for most part of the time, use simple gear; part-time fishers, who fish during part of the year; and professional fishers who live entirely by fishing (Welcome, 1985). The most preferred commercial fish species are *Oreochromis spp*, *Serranochromis spp, Hydrocynus vittatus* (Mosepele, 2001). Most of these species are also the preferred species for subsistence fishers, while preferred fish species for recreational fishing are bream and the tiger fish (*Hydrocynus vittatus*). Figure 3 shows household net private value of both traditional and gillnet fishers in the Delta. The total net private value of traditional fishery and gillnet fishery were estimated at BWP657 883 and BWP1031, respectively (Turpie *et al.,* 2006). The net private value per household of traditional fishery was highest in the Panhandle, while that for gillnet fishery was highest in the central part of the Delta as shown in Figure 3.

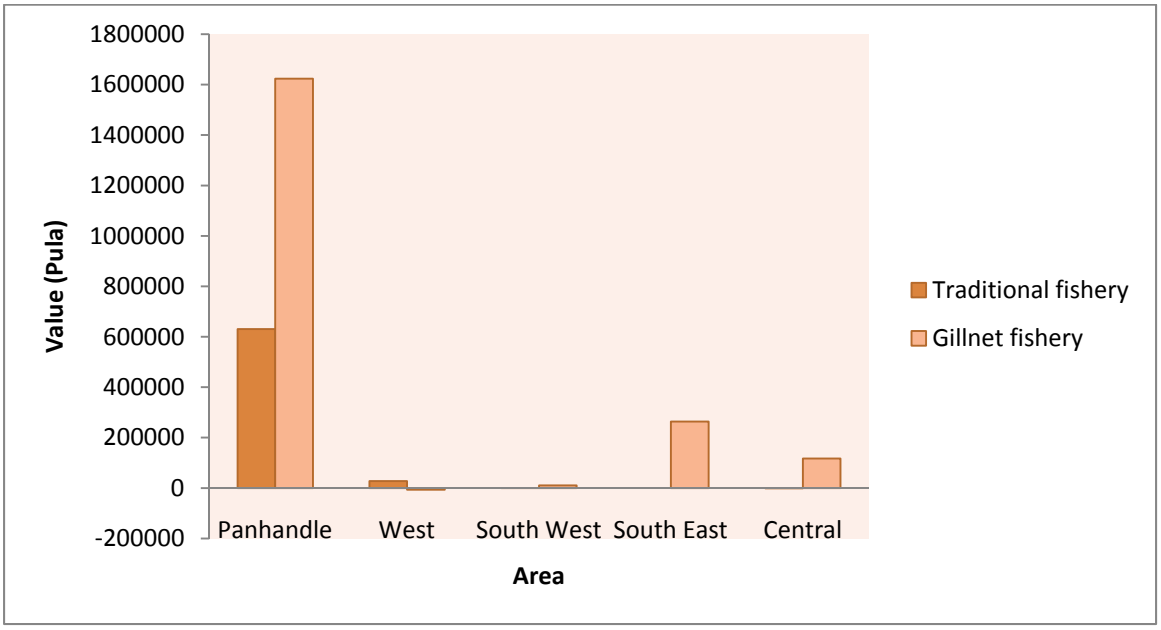

Figure 3: Household net private value (BWP) for fishing in different areas of the Delta (2005 prices) (Source: Turpie et al., 2006)

1.2.4. River reed, grass and papyrus and palm leaves

River reed (*Phragmites spp*) is harvested on an open access basis in the Delta. Its direct use value arises from harvesting it for household use and income generation (Barnes *et al*., 2001). It is generally used in fencing of courtyards, construction, making different types of fish catching equipment such as fishing baskets and making floor mats. Turpie *et al.* (2006) estimated the total household net private value in different areas of the Delta at BWP2 252 361. The highest

net private value per household of the harvested river reed was in the south east of the Delta,while the smallest was in the central part of the Delta (Figure 4).

Grass is harvested from the river and is used as a roofing material. Turpie *et al.* (2006) estimated that 174 000 bundles of thatching grass annually are collected from Panhandle, west, south west, south east and central of the Okavango Delta. The total household net private value of grass was estimated at BWP3 087 761 (Turpie *et al.,* 2006) which is higher than that for river reed. Households in the Panhandle had the highest net private value of grass than in other areas of the Delta.

Papyrus (*Cyperus papyrus*), found in permanently inundated channels and pools, is used in making sleeping mats that are sold for income. It is collected mostly in the panhandle and in the central part of the Delta (Turpie *et al.,* 2006). Since papyrus is generally not sold, its value is much lower than for grass and reed (Figure 4). The net private value per household of the harvested papyrus was highest in the central part of the Delta.

Palm leaves are important in basket weaving and making other handicrafts that are sold for income. The leaves are used together with other plant parts to make baskets. For instance, the roots of *Berchemia discolor* are used for dyeing the leaves. Palm leaves are not usually sold like other products. The total household net private value of palm leaves in the Panhandle, west, south west, south east and central of the Okavango Delta, was estimated by Turpie *et al.* (2006) to be BWP1 787 837. Households in Panhandle had the highest net private values of harvested palm leaves (Figure 4).

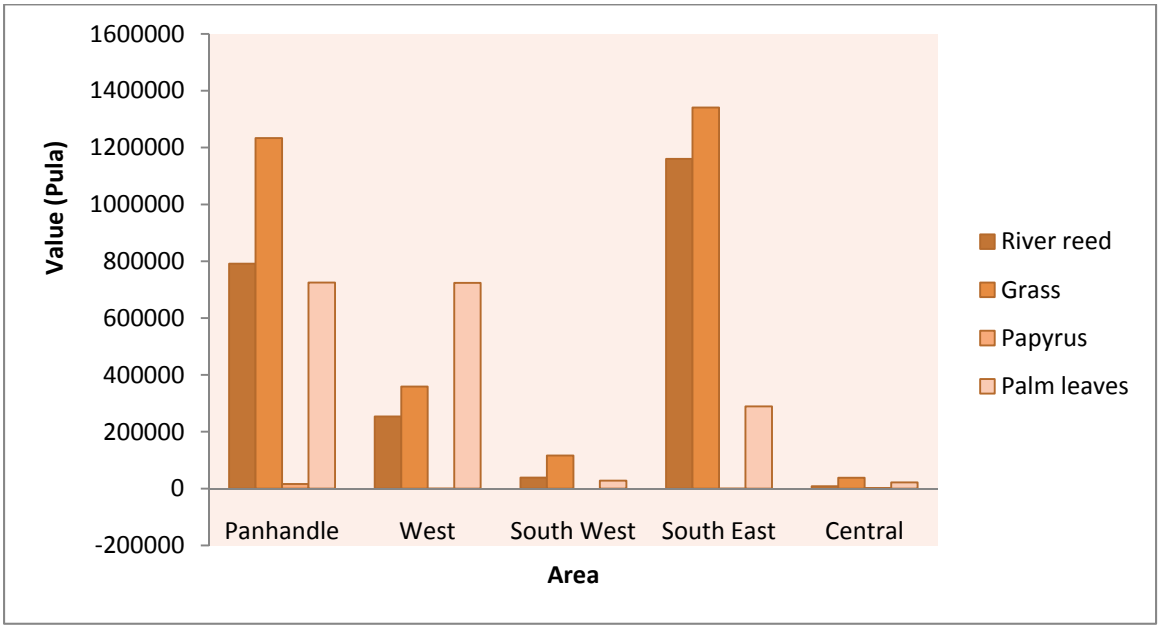

Figure 4: Household net private value (BWP) for river reed, grass and palm leaves in different areas of the Delta (2005 prices) (Source: Turpie et al., 2006)

1.2.5 Poles, timber and fuelwood

Woody resources are important as they have a variety of uses in the Delta. Poles are used as fencing materials and in general construction, while timber is used for making various products including canoes, hoe handles, yokes, tables, doors, chairs, and pounding pots (Turpie *et al.,* 2006). Fuelwood is used as source of energy. Many tree species are used as source of fuelwood. Table 4 shows the household net private value for poles, timber and fuelwood in different areas of the Delta. The values of poles, timber and fuelwood were estimated at BWP1 681 222, BWP568 697 BWP8 581 022, respectively (Turpie *et al.,* 2006). The net private value per household of poles harvested from the Delta was highest in the south west of the Delta, while the highest for timber was in the Panhandle of the Delta (Figure 5). Households in the west of the Delta had the highest net private value of firewood collected than in other areas.

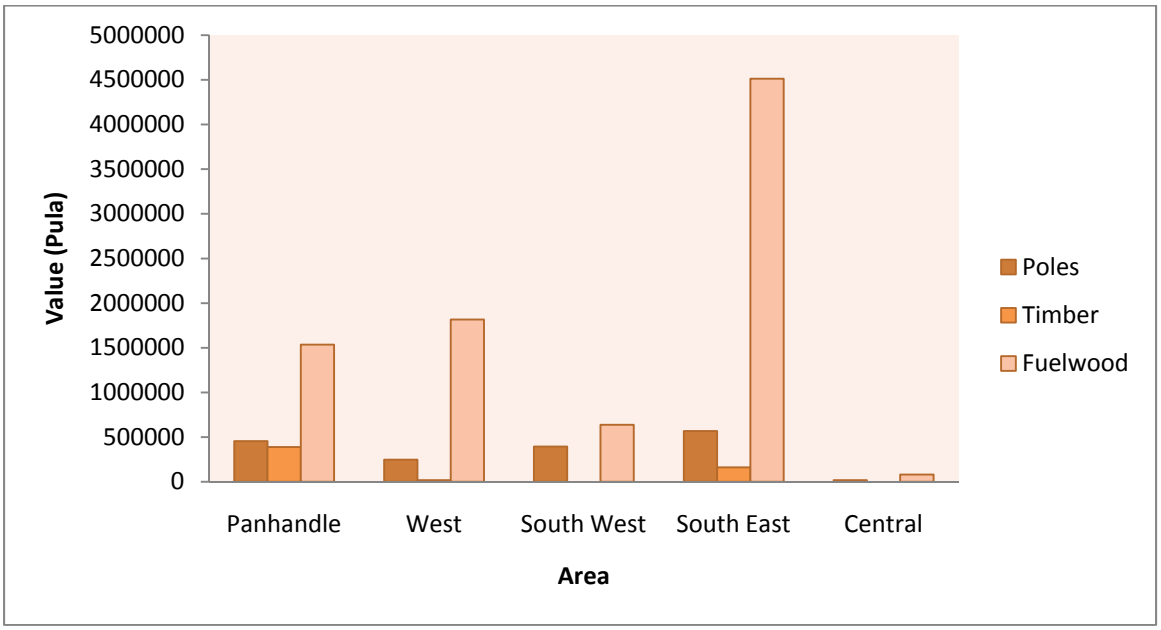

Figure 5: Household net private value (BWP) for poles and timber in different areas of the Delta (2005 prices) (Source: Turpie et al., 2006)

1.2.6 Wild foods, upland foods and medicinal plants

A variety of wild foods are harvested in the Delta. They include monkey orange *(Strychnos cocculoides),* spiny leaved monkey orange *(Strychnos pungens),* kalahari pobery *(Dialium engleranum),* false brandybush *(Grewia bicolor),* brandybush *(Grewia flava*), large sour plum *(Ximenia caffra),* rough-leaved raisin bush *(Grewia flavascens*), rough-leaved raisin bush *(Grewia retinervis*), makettii tree *(Recinidendron rautenenii*), African mongostein *(Garcinia livingstonei),* bird plum *(Berchemia discolor),* water lily *(Nymphaea caerula)* and African ebony *(Diospyros mespiliformis) (*Mmopelwa, 2006*).*

The main wild fruits often sold in the market include *Strychnos cocculoides*, *Strychnos pungens*, *Grewia bicolor, Grewia flava, Garcinia livingstonei Berchemia discolor* and *Nymphaea caerula.* Turpie *et al.* (2006) estimated the household net private value of wetlands foods in the in the Panhandle, west, south west, south east and central of the Okavango Delta, at BWP 99 207. The highest net private value per household of wild foods collected was in the Panhandle, while the least was in the south east of the Delta (Figure 6).

A number of plants are also harvested and used as traditional medicine. They include *Diospyros lycioides, Bauhinia variagata, Terminalia serecea, Combretum collinumn, Recinidendron rautenenii, Acacia erioloba, Acacia tortilis, Adansonia digitata, combretum imberbe, Bocia albitrunca, Acacia galpinii, Rhus tenuinervis, Clerodendrum ternatum, Ximenia americana, Melhania griquensis, Enicostema ascillare, Combretum hereroense, Pterocarpus capasa, Ficus sycomorus, Gardenia spatulifolia,, Croton megalobotrys, Albizia anthelmentica, Colophospermum mopane, Ficus thonningii, Euclea divinorum and Harpagophytum procumbens. The* total household net private value for medicinal plants was estimated at BWP277 729.8 (Turpie *et al.,* 2006). The highest per household value of medicinal plants was in the western part of the Delta, while the smallest was in the central part of the Delta (Figure 6).

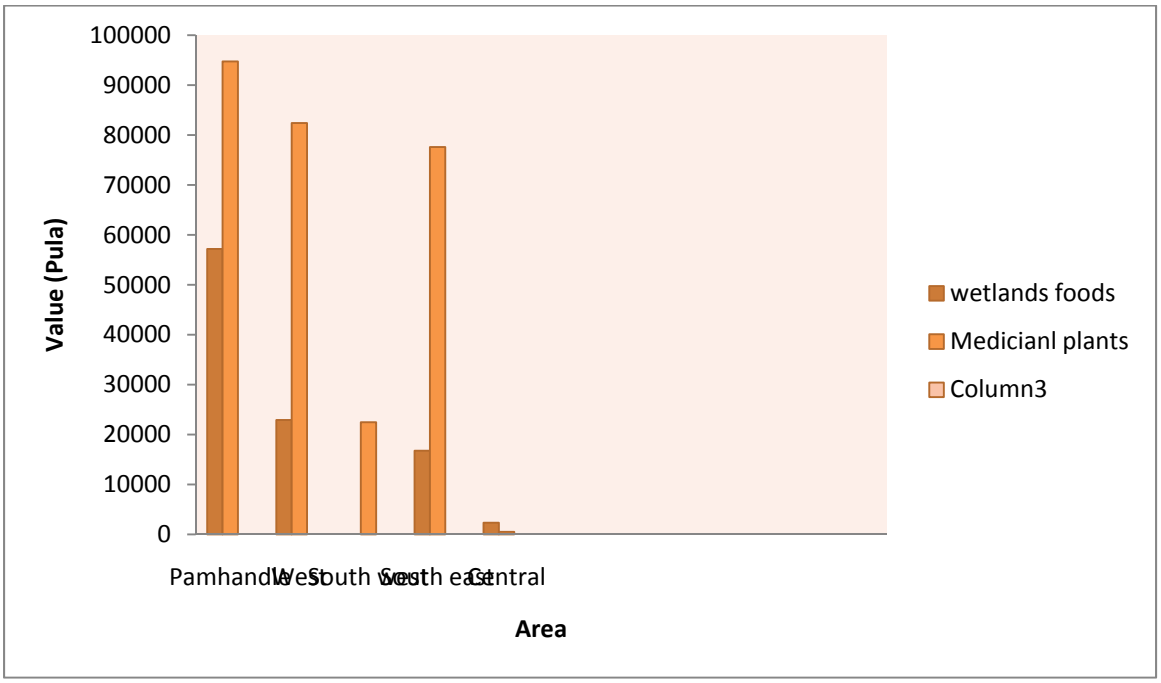

Figure 6: Household net private value (BWP) for wetlands foods and medicinal plants in different areas of the Delta (2005 prices) (Source: Turpie et al., 2006).

1.2.7 Tourism

The Okavango Delta supports a large tourism industry, the second most important economic activity after diamonds. The importance of tourism in the country is evidenced by a build-up of lodges and increasing tourist visitors from all over the world. Wildlife based tourism in the Delta provides 40% of employment opportunities in the north (Tupie *et al.,* 2006). The main tourism attractions are the complex mosaic of dryland, island fringe, wetland habitats, and associated wildlife diversity that include big and small game, birds, fishes, reptiles and amphibians

(Masundire *et al.,* 1998; Ashton *et al.,* 2003). One of the game reserves, Moremi (3880 sq. km), located in the northern eastern part of the Okavango Delta, is an area of considerable ecological diversity and scenic beauty particularly with its wilderness combinations of water, riverine woodland and wildlife (Barnes, 1998). The Delta provides an appealing scenery and novel recreational activities that include canoe rides, site-seeing, motor boat cruises, and game fishing (Rothert, 1997; Mbaiwa, 2002; Gumbricht *et al.,* 2004). Further, the river system provides a medium for traditional transport and communication, primarily through the use of boats. The dug–out canoe has been adopted by the tourist industry as a way for tourist to experience the Delta (Cassidy, 1997).

A number of studies (e.g. Mmopelwa *et al.,* 2007; Mmopelwa and Blignaut, 2006; Turpie *et al.,* 2006; Kgathi *et al.,* 2008) have been undertaken to estimate the values associated with tourism activities. For instance, the gross (direct) output of tourism in the Okavango Delta Ramsar site was estimated at BWP1115.8 million, while the gross value added was estimated at BWP 401 million (Turpie *et al.,* 2006). The contribution of the various components of tourism are shown in Table 1.

Table 1: Estimated value of annual gross output and gross value added (BWP) in the Okavango Delta based tourism

Component	Gross output	Gross value added
Non-consumptive tourism	899.7	310.6
Hunting tourism	172.5	67.2
CBNRM tourism	40.1	16.8
Total	1115.8	401.0

Source: Turpie et al. (2006)

The sources of revenue are park entry fees, accommodation (camping fees), vehicle fees, boat fees, aircraft landing fees and other fees (such as filming and permit renewals for guides). Park entry fees and camping fees are P120 and BWP30 per person per day, respectively. Mmopelwa *et al.* (2007) found in Moremi Game Reserve that overseas visitors were willing to pay more for park and camping fees, provided that Moremi game reserve was to be managed by an independent conservation organization. They were willing to pay an increase of BWP29 for park fees and and BWP9 for camping fees per tourist.

In another survey of tourists in the Delta, Kgathi *et al.* (2008) estimated the total expenditure of tourists for the whole trip to the Delta (including the costs of multiple destination travellers and single destination travelers) to be USA$ 5704.00. The study calculated the mean consumer surplus accruing to tourists in the Okavango Delta to be USA$ 235 or 7% of the mean expenditure for the Okavango Delta trip. Using an estimate of 40-50 000 tourists who visit Moremi Game Reserve annually, the authors estimated the untapped consumer surplus that accrues to wildlife viewing tourists to be between USA$ 9.4 million to 11.8 million per annum. Clearly, the potential consumer surplus is well above these figures because some of the tourists from other market segments outside Moremi Game Reserve are not included in the calculation (Kgathi *et al.,* 2008).

1.2.8. Overall value of wetland resources

The total net private value of resources is shown in Figure 7. The highest values were those of cattle kept in cattle post, with annual values of above BWP50 million. This shows the importance of livestock farming in the study area. All other values were below BWP10 million. The smallest net private values were of medicinal plants and timber.

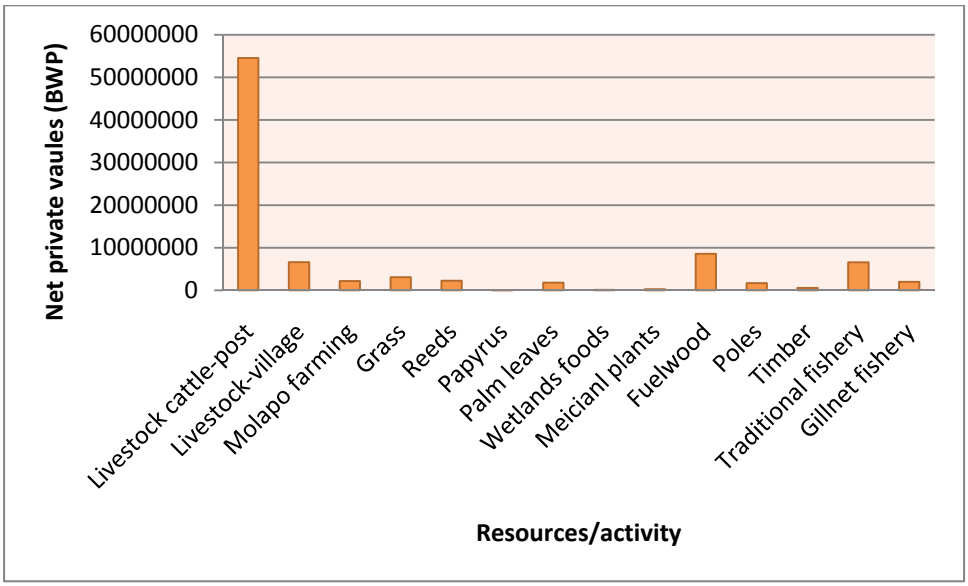

Figure 7: Overall household net private values of resources (2005 prices) (Turpie et al., 2006)

2. ASSESSMENT OF LIVELIHOODS; RELIANCE ON RIVER AND ASSOCIATED RESOURCES FOR HOUSEHOLD INCOME FOR REPRESENTATIVE SOCIAL AREAS WITHIN BOTSWANA PORTION OF THE OKVANGO RIVER BASIN

2.1 Introduction

The assessment or analysis of livelihoods in this section follows the sustainable livelihood framework which presents the main components of and factors affecting people's livelihoods (Figure 8). Scoones (1998) defined a *livelihood as comprising the capabilities, assets (including both material and social resources) and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stress and shocks, maintain or enhance its capabilities assets while not undermining the natural resource base.*

Household livelihoods are affected by an external environment, often called the vulnerability context (Department for International Department, 1999; Scoones, 1998). The vulnerability context is the risk factors surrounding making a living (Ellis and Freeman, 2005). This is the environment which the farmer has no control over. The components of the vulnerability context include trends, shocks, and seasonal shifts (Department for International Development, 1999). Shocks are sudden unpredictable disturbance such as flood and epidemics (Scoones, 1998). Trends are more predictable and include factors such as continuing/declining rainfall, changes in population and expansion of local economy (Brock, 1999). Seasonal shifts in prices, employment opportunities and food availability can also affect livelihoods in a negative or positive manner (Department for International Development, 1999).

Within a livelihood framework, five types of capital or assets are identified: natural capital (the stock of natural resources and environmental services from which livelihood are derived), physical capital (infrastructure, tools and technology); financial capital (cash, credit, remittances, pensions, wages and other economic assets), human capital (skills, knowledge and labour to enable household to pursue livelihood strategies), and social capital (net works, social relations and associations which people draw upon to pursuing different livelihood strategies) (Krantz, 2001).

Households combine different activities (e.g. fishing and livestock farming) to achieve certain goals. The combination of various activities by households is referred to as livelihood strategies (Department for International Development, 1999). Depending on seasonal cycles, households may pursue different activities simultaneously or sequentially, with certain activities more specialized than others (Scoones, 1998).

Households' goals of combining different activities are referred to as livelihood outcomes. Households may pursue different portfolios for increased income, increased wellbeing, improved food security, reduced vulnerability or more sustainable use of resources) (Scoones, 1998). Most households have a great diversity of livelihoods strategies primary because they have to cope with stress and shock. When a household is able to cope with an external force such as drought, then the livelihood of that household is socially sustainable (Krantz, 2001).

People's decisions to combine different activities (livelihood strategies) for desired outcomes are affected by policies that exist at local, national, regional and international levels and institutions and processes (Scoones, 1998). Institutions or patterns of behavior are governed by normal rules of a society and mediate access to livelihood resources, ultimately affecting livelihood strategies and outcomes (Krantz, 2001).

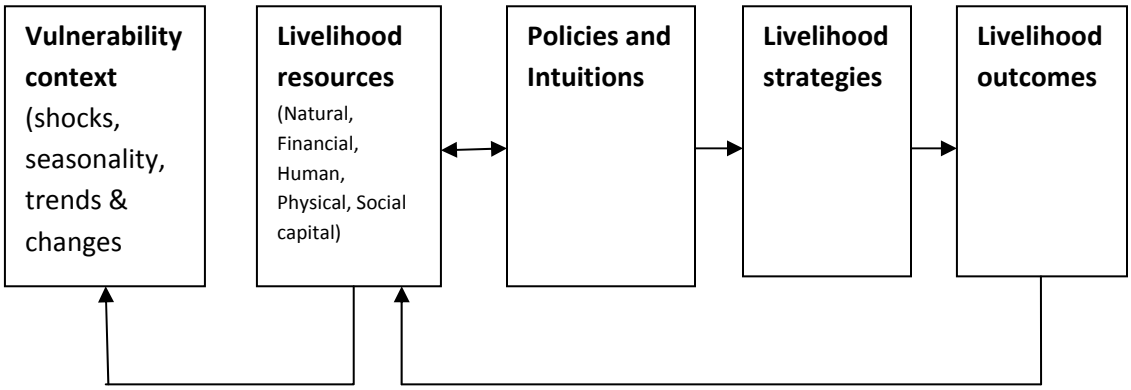

Figure 8: The Sustainable livelihood framework

(Source: Adapted from Scoones, 1998)

2.2 Livelihood resources and household resource utilization

2.2.1 Natural capital

Most of the rural based livelihoods in the Okavango Delta are natural resource based. Fresh water is an important natural capital. It is used for domestic purposes, drinking cooking bathing and personal hygiene, watering gardens, brick moulding and livestock consumption. Surface water is sourced directly from the river as well as from standpipes. Before being widely distributed through standpipes in the village, surface water from the river is treated (Mmopelwa, 2006). Villages that are distantly located from the river are supplied with water from boreholes recharged by the river.

A range of wild plants and animals that contribute to livelihoods are harvested from the wild (Applied Development Consultants 2001; Turpie *et al,* 2006; Government of Botswana, 2003). The plant based natural resource capital include river reed (used as building material, making court yard fences, fishing baskets and handicrafts such as mats); papyrus (used in making of basket and carpets); grass (used as roofing material); wild foods (used for household consumption and sale); poles and timber (used as building materials, making mortar and pistil, carving of canoes and household use); firewood (used as a source of energy) and medicinal plants (used traditionally to cure various ailments). Many of these natural resources can also be sold directly for income or can be used to make other products.

Among the natural capital users, two groups of stakeholders can be identified. The first level of people is the primary stakeholders who are directly dependent on resources and derive immediate benefit from the resources in pursuance of livelihood activities, while the second group is that of secondary stakeholders (e.g. tour operators), who do not directly depend on natural resources as they usually derive benefit from the resources at a much higher commercial level than primary stakeholders (ODMP, 2006). The first level of stakeholders are usually the poor who are dependent on these resources for subsistence and food security needs They are usually vulnerable as they lack, assets, savings and alternative means of or options to deal with shocks and stress (Shackelton *et al.,* 2008).

Table 1 shows household dependence (household percentage) on natural resources in different areas of the Delta. In the Panhandle, west, south west, south east and central of the Delta, households using fuelwood constituted the highest percentage. The second most important resource in the Panhandle was river reed (69%), and wild food in other areas (53% in the west, 64% in the south east and 65% in the central) of the Delta.

Table 2: Percentage of household harvesting resources in the Panhandle, west, south west, south east and central of the Delta

Resource	Panhandle	West	South west	South east	Central
Pottery	3	0	2	1	0
Wetland grass	61	21	2	5	18
Upland grass	8	12	18	16	35

River reed	69	33	7	18	22
Papyrus	10	1	0	1	12
Palm leaves	12	42	7	29	41
Wild foods	57	53	64	57	65
Medicinal plants	12	12	19	16	10
Firewood	77	86	98	85	96
Timber	1	1	0	1	0
Poles &withies	49	28	34	28	47
Fish	34	6	4	6	20
Honey	2	1	1	2	2
Hunting	36	49	43	42	61

(Source: Adapted from Turpie et al (2006) household survey)

Differences in household dependence of resources is a function of a number of factors including the availability of resources which in most cases will be determined by the natural conditions such as flooding, proportion of the population using a particular resource, the effort (labour) required to harvest the resources, the market demand for the saleable natural resources or their products.

The implication of direct dependence of primary stakeholders on resources is that should the availability of resources be adversely affected by environmental shocks such as drought or flood variability, within or outside Botswana, their wellbeing will be seriously affected because they lack the means of buffering against such impacts. In a survey of Applied Development Research Consultants (2001), 70% of the communities reported that fish, river reed, water lily and grass had declined due to over-exploitation and reduction and flooding and rainfall.

2.2.2 Physical capital

Physical capital refers to the basic infrastructure and producer goods needed to support livelihoods such as affordable transport and secure shelter (Department for International Development, 1999). Cattle as a source of draft power is one of the most important physical capital in the Delta, though its ownership is skewed, and as result many other households do not have access to draught power (Bendsen and Meyer, 2003). Other physical capital that relate to fishing includes storage facilities of fishermen, which are of poor standards because fishers lack financial resource to maintain them. Fishers also lack transport to market their fish in other areas (Mmopelwa and Ngwenya 2008b).

2.2.3 Human capital

Most resources are harvested by households using family labour. In certain activities, there is division of labour. For instance, fishing is predominantly a male dominated livelihood activity. Women are involved in fishing at subsistence level and use fishing baskets as their fishing gear (Mosepele, 2001). The other form of capital among fishermen is indigenous knowledge regarding the catching fish. While most fishers have a generally low level of education and marketing skills, (Mmopelwa and Ngwenya, 2008b), they posses extensive indigenous knowledge regarding the appropriate time for fishing, fish migration as well as the location of fish breeding sites. They use this knowledge in catching preferred species of fish (Mosepele *et al.,* 2007). This knowledge is passed on from one generation to the next. Indigenous knowledge of resource users is further found among basket making. Basket weaving is very skillful activity that is leaned. As with the skills in fishing, those in basket weaving are also learned and transferred from one generation to the next.

2.2.4 Financial capital

Most farmers lack financial resources. They are too poor to access credit because they do not have do collateral. The level of investment among famers is thus, very low (Mmopelwa and Ngwenya, 2008b). Famers who own cattle convert them to cash as cattle are liquid assets. Other households have remittances as sources of income.

2.2.5 Social capital

Social capital has expanded through community based organization (CBOs) such as trusts and associations, but has contracted through decreases in traditional extended family systems (Arntzen, 2005; Wilk and Kgathi, 2007). Members of the community benefit not only financially and materially, but also non-materially such as by building mutual trust among the resource users with common interests (Department for International Development, 1999). By being part of community organisation with common interests, they reduce free riding problem as well as or conflicts which may otherwise emerge. There are currently seven (7) community trusts in partnership with a safari tour operator in Delta. The trusts comprise 1-5 villages. In commercial fishing, fishing syndicates have been formed as a way of reducing transaction costs in the fishing enterprise as well as to be able to access government aid. For example, when the Financial Assistance Policy (FAP) was in force, fishers were able to acquire fishing equipment (e.g. fishing nets) by virtue of being members of the fishing syndicate.

2.3 Livelihood activities, strategies and outcomes

Households make choices about a combination of activities for desired outcome. In most cases, household combine different activities in order to spread risk (Turpie *et al.,* 2006). In a survey of fishers in the Panhandle, Mmopelwa and Ngwenya (2008a) found that of all the fishing households in the study area, 80% were also involved in crop farming, while 40% were involved in livestock farming.

2.3.1 Livestock farming

The primary means by which the Okavango Delta supports livestock farming is through supply of water and grazing grounds. Most of the aquatic habitats in the Delta have vegetation comprising grass and herb species which are highly palatable to livestock (Kwerepe, 1995). In many African societies, including Botswana, livestock is kept for economic and cultural reasons (Burret, 1991; Ouma *et al.,* 2004). Cattle, especially, have become more important valued livestock species in many developing countries because of the range of values that they possess (Randeli, 2003). They are a source of protein rich food supplies such as meat and milk, cushioning smallholder farmers especially against starvation during food scarcity (Bendsen and Meyer, 2003; Randela, 2003). They have also become an important source of cash because they can easily be converted to deposable income, enabling households to meet expenditures such as the payment of school fees of children (Ouma *et al.,* 2004). Cattle are also used as source of draught power, manure and transport (Burret, 1991; Bendsen and Meyer, 2003). They are also used as payment for bride and slaughtered during funerals and weddings ceremonies. They are also viewed as a store of wealth or living assets for future planned expected needs (Ouma *et al.,* 2004). In years of drought or other times of crisis in the family, cattle become an important asset which the farmer can turn to (Burret, 1991). Thus they also perform insurance roles because the capital invested in a herd forms a guarantee for meeting future unexpected requirements (Ouma *et al.,* 2004). Cattle also are valued for the spiritual and cultural roles (Burret, 1991). The occurrence of drought in the 1980's and the outbreaks of the lung diseases (Contagious bovine pleuro-pneumonia) in 1995 and the Foot and Mouth diseases have affected cattle numbers in negative ways (Arntzen, 2005; Bendsen and Meyer, 2003; Wilk and Kgathi, 2007). Drought event led to decreases in the number of cattle. The outbreak of the contagious bovine pleura-pneumonia lead to eradication of the entire herd of cattle leading to limited livelihood options (Bendsen and Meyer 2003; Arntzen, 2005). Another impact on livelihoods has been the erection of fences within Botswana and between Botswana and other riparian countries especially Namibia in an effort to control the transmission of cattle diseases. Locally, disease control fences have to a large extent resulted in limited access to natural resource harvested (Kgathi *et al.,* 2004; Arntzen, 2005).

2.3.2 Arable farming

There are two distinct farming practices in the Delta, and these are dryland and flood recession farming. Dryland farming is dependent on rainfall. It is practiced at traditional level and characterized by minimal production inputs and often low returns because it depends largely on unpredictable environmental conditions that are beyond the control of the farmer (Bendsen and Meyer, 2003). Because of dependence of dryland farming on natural environmental conditions, yields can vary considerable from year to year and from crop to crop (Bendsen and Meyer, 2003). Common crops in dryland farming include sorghum and millet which are more drought tolerant than maize.

Flood recession farming is dependent on residual flood moisture in the fringes of the Delta. During high flood season, significant quantities of water spreads over the Delta and when the flood recedes melapo land dry up due to evapo-transpiration and water infiltration leaving, the land suitable for cultivation (Bendsen and Meyer, 2003). The most common crop grown under flood recession agriculture is maize. Crop yields under flood recession agriculture are generally higher than in dryland farming. For instance, up to 1500 kg/ ha of sorghum has been reported in

flood recession agriculture as compared to 500kg/ha of sorghum under dryland farming (Bendson and Meyer, 2003). Since flood recession agriculture depends on floods, changes in flooding patterns resulting from natural anthropogenic effects may affect the area cultivated under Molapo farming (Kgathi *et al.,* 2006). For instance, desiccation of river channels owing to the natural geographic shifts in the flow of water, affects local community dependence on water as well as the amount of area that may be cultivated under flood recession agriculture (Kgathi *et al.,* 2006; Wilk and Kgathi, 2007).

2.3.3 Fishing

Fishing is one of the primary livelihoods in the Delta, especially in the Panhandle (Government of Botswana, 2003; Arntzen 2005; Mmopelwa *et al.,* 2009). Subsistence and commercial fishing are very common in the settlements like Samochima, Sepopa and Ngarange (Government of Botswana, 2003). Three types of fishers are found in the Okavango Delta fishery, and these are subsistence fishers, commercial and sport fishers (Mosepele, 2001). Subsistence fishers usually fish for home consumption, but also fish to trade or sell part of their fish catches. Since they sell part of their catch, they can also be referred to as semi-commercial fishers. They use simple fishing gear technology such as hook and line and some traditional gears such as fish spears (Mosepele, 2001). Women fishers use fishing baskets in shallow water (Mmopelwa *et al.,* 2009). The use of subsistence based fishing gears such as traditional hook and line results in low annual fish off-take from the Delta fishery (Mosepele *et al.,* 2003). Commercial fishers use modern fishing gears such as engine powered boats, gill nets and refrigeration or cold storage facilities (ODMP, 2006). They target highly valued fish species such as large bream (*Orechromis andersonii*, *Orchromis machrochir*, *Tillapia rendalli* and various *Serrannochromis* species (Government of Botswana, 2003). The inter and intra annual variation in the Okavango Delta flood systems results in short-term temporal and spatial variations in fish species availability (Mmopelwa *et al.,* 2009). However, fishers have always coped with the systems through various mechanisms such as by diversifying their livelihood strategies.

2.3.4 Basket weaving

Basket making has been an important commercial activity since the early 1970s and has provided employment for a number of people (Kgathi *et al.,* 2005). Terry (1999) estimated the economic benefit of basketry at BWP225 000.00 which accounted for 7% of the total economic value of all natural resources used in craft production. The raw materials for basket weaving are mainly plant based. Younger leaves of Mokola palm tree (*Hyphaene pertersiana*) are harvested for basket weaving. The roots and/or barks of the bird plum (*Berchemia discolor*) and the diamond-leaved Euclea (*Euclea divinorum*) are used to produce a decoction for dyeing (Cunningham 1988; Government of Botswana, 2003). The roots of *Berchemia discolor* are used to produce red dye while those of *Euclea divinorum* are used to produce brownish dye.

2.3.5 Community based tourism

In the recent years, growth and development of the tourism sector has led to the establishment of community based tourism, which is based on the premise that communities living with or adjacent to wildlife resources stand to derive livelihood benefits if they are made custodians of those resources. According to Mbaiwa (2004b), the Tourism Policy of 1990 the Wildlife Conservation Policy of (1986) provided the basis for community based tourism. Following these and other policies, communities living adjacent to controlled hunting areas (CHA's) were encouraged to form and register trusts. The registered trusts are then granted land with its wildlife resources which the community or trust can lease to a safari operator who has the knowledge and skills of running a tourism enterprises such as safari hunting (Mbaiwa, 2004a). The benefits accruing to the trust are the payment of lease rental and annual wildlife quota by

the tour operator or safari partner to the community**.** Thus, the community benefits financially from this partnership arrangement while undertaking conservation of wildlife resources. As with many other livelihood activities, community based tourism is dependant on the available water that sustains wildlife resources which is the necessary natural capital for community based tourism**.** In the event that flooding regimes change in upstream of the Delta, community based tourism may be affected negatively or positively.

3. ASSESSING FOOD SECURITY AND NUTRITION VALUE ASSOCIATED WITH RIVER AND ASSOCIATED RESOURCES WITHIN EACH REPRESENTATIVE SOCIAL AREA.

3.1 Introduction

According to Food Summit (1996) food security is "a condition when all people, at all times, have physical and economic access to sufficient, safe and nutritious food at the individual or household level". Poor people are more likely to be food insecure because they lack access to sufficient food (FAO, 2005). Worldwide, governments have instituted social safety net programmes for poverty alleviation. Poverty alleviation is an encompassing term and includes poverty prevention and poverty reduction. Poverty prevention refers to a situation where people are becoming measurably better over time either in absolute or relative terms, while poverty reduction refers to a situation whereby people are assisted to maintain a minimum standard of living (even when it is below a given poverty line) and helping them to survive (Angelsen and Wunder, 2003). In Botswana social safety net programmes include home based care programme, school feeding, old-age pension and drought relief programs (Department of Social Services 2006).

While social safety net programmes are widespread, there has been a general lack of understanding of the critical role of natural safety net in food security (Shackelton *et al.,* 2008). Products of wetland are critical for food security. They are a source of variety of food that supplement and complement what is normally consumed at the household level (Arnold, 2008). Products of wetlands contribute directly to food security through their supply, (e.g. subsistence utilization), or indirectly through revenue generation from production and marketing (FAO, 2005). For instance, in the Panhandle of the Delta, Mmopelwa and Ngwenya (2008) estimated the annual value of fish per commercial fisher to be BWP14397.9

Wetland products contribute to overall food diet in terms of quantity and in meeting the nutritional requirements. Nyepi *et al.* (2008) reported that green leafy vegetables harvested during the rainy season and high flood season and tubers (*Nymphaeas* family) harvested during low flood season in the Panhandle, contributed to nutrition security as well as dietary diversity for most of poor households. Wetland products such as fish are a preferred source of animal protein with balanced amino-acid and essential minerals for healthy human growth (Meusch *et al.,* 2003

3.2 Role of wetlands resources as safety nets

Many of the wetlands including the Okavango Delta, provide a critical safety net function for the riparian households as they become as source of food during emergency period such as drought, famines, floods and sickness (Arnolds, 2008; Mmopelwa and Ngwenya, 2008). In this respect these products reduce household risk and vulnerability to falling deeper into poverty. The products derived from wetlands may not be the principle cash earners but perform a critical function of *gap filling* (Angelsen and Wunder, 2003). When essential or main staple foods are not available during a particular time or season of the year, products of wetlands increasingly

become important as they provide a seasonal buffer during this time. During this time they can be consumed directly or sold to generate income. The income derived from the sale of these products as quick casht can be used to overcome shortfall in family illness (Angelsen and Wunder, 2003).

One of the important natural safety nets in the Okavango Delta is fish. In two villages in the Panhandle, 89% of the surveyed households cited a number of reasons that make fish a critical safety net (Mmopelwa *et al.,* 2008). First, households in the survey reported that fish in the Panhandle was an abundant aquatic open access resource exploited by households all year round. Being an open access resource, households are able to access it to meet their daily nutritional and income needs. More importantly, the income from fishing is used to meet other household needs such as payment of school fees for children and purchase of other food items in the household (Mmopelwa *et al.,* 2008). Second, fish is easily bartered with most food commodities such as grains or other food commodities. In this study about 60% of gillnet fishers and 25% of hook and line fishers reported that they barter fish during the critical shock period. Third, fish is easily processed through smoking or sun-drying, and stored to be used during times of emergencies such as drought. In the same study, fifty five percent (55%) of the gillnet fishers and 15% of basket fishers and 30% of hook and line fishers reported that they processed fish through smoking and sun-drying in order to use to use it during critical time periods.

The participation of community on tourism also contributes to poverty alleviation. Existing joint venture partnerships between communities and a safari operator makes it possible for communities benefit to benefit. Communities benefits from tourism in the following ways: employment of the poor in tourism enterprises (e.g. providing guiding services), supply of goods and services to tourism enterprises (e.g. maximizing the proportion of visitor spending that is retained in the local community), direct sales of goods and services tourists (e.g. sale of handicrafts) (vander Duim and Henkens, 2007). The availability of wetland products as influenced by hydrological regime and the contribution of community based tourism as dependent on the Delta resources has serious implications for food security in the area.

4. CONCLUSION

Most households' livelihoods in the Delta are supported by various natural resources. The highest net private values of livestock farming, flood recession agriculture, medicinal plants and fuelwood, were recorded in the western part of the Delta, while the highest values of grass, palm leaves, timber and wild foods were recorded in the Panhandle. In the south east of the Delta net private values were those of river reed and poles, while in the central part of the Delta the highest net private values were those of fishing and papyrus harvesting. Changes in flooding resulting from socio-economic developments, policies affecting the utilization of shared water or other kinds of shocks in either Angola or Namibia, are likely to result in changes in flows downstream (Botswana), which in turn may positively or negatively affect water dependent livelihood activities such as fishing or economic values associated with such activities. Where the effects will be negative, the impacts will be felt more by households directly dependent on river related resources. This will inevitably, have implication on food security and poverty alleviation.

5. REFERENCES

Adger, N., Brown, K., Cervigni and Moran N, D. (1994). Towards estimating total economic value of forests in Mexico. CSERGE Working paper GEC 94-21

Angelsen, A. and Wunder, S. (2003). Exploring the forest-poverty link: Key concepts, issues and research implications. CIFOR Occasional Paper No. 40. Centre for International Forestry Research Jarkata.

Applied Development Research Consultants (ADRC). (2001). A Report on the Socio – Ecological Survey of the Okavango Basin, Kalahari Conservation Society, Gaborone.

Arnold, J.M.E. (2008). Managing ecosystems to enhance the food security of the rural poor: A situation analysis prepared for the IUCN (available from:.. access on)

Arntzen, J. (2005). Livelihood and biodiversity in the Okavango Delta, Botswana. Report pprepared for the PDF-B stage of the GEF project' Building local capacity for the conservation and sustainable use of biodiversity in the Okavango Delta' Centre for Applied Research, Gaborone

Ashton, P.J., Nordin, L. and Alonso. L.E. (2003). Chapter 1: Introduction to the Okavango Delta and the AquaRap Expedition, In: Alonso. L.E. and Nordin, L (eds), A Rapid Biological Assessment of the Aquatic Ecosystems of the Okavango Delta, Botswana: High Water Survey (pp. 29-37). RAP Bulletin of Biological Assessment No. 27. Conservation International, Washington.

Barbier, E.B., Acreman, M. and Knower, D. (1997). Economic Valuation of Wetlands: Guide for Policy and Planners. Ramsar Convention Bureau. Gland.

Barnes, J. I., Cannon, J. and Morrison, K. (2001). Economic Returns to selected Land Uses in Ngamiland, Botswana. Conservation International, Maun

Barnes, J. I. (1998). Wildlife Economics. A study of direct use values in Botswana's wildlife sector. PhD Thesis submitted to the University of London, London.

Brock, K, (1999). Implementing a sustainable livelihoods framework for policy –directed research: Reflections from practice in Mali. IDS Working Paper IDS No. 90

Bendsen, H. and Meyer, T. (2003). The Dynamics of Land Use Systems in Ngamiland: Changing Livelihoods Options and strategies. Available from: http://www.Okavangochallenge.com

Burret, J.C. (1991). The economic role of cattle in communal farming systems in Zimbabwe. Proceedings of a conference on The socio economic impact of improved tickborne disease in Zimbabwe, Harare.

Cassidy, L. (1997), Diagnostic Assessment: Human Environment- Botswana Sector. OKACOM.

Daily, G.C., Alexander, A., Ehrlich, P.R., Goulder, L., Lubchenco, J., Matson, P.A.,Mooney, H.A., Postel, S., Scheneider, S.H., Tilman, D., Woodwell, G.M, (1997). Ecosystem services: Benefits supplied to human societies by natural ecosystem. Issues in Ecology, 2: 1-16

Cunningham, A.B. (1988). Leaf production and utilization in *Hyphaene coriacea*: Management guidelines for commercial harvesting. *South African Journal of Botany* 54(3) :189-195

Department for International Development (1999). Sustainable Livelihoods Guidance Sheet. Eldis Document Store.

Department of Social Services (2006). Provision of psychological services to orphans and vulnerable children in Botswana: Issues and challenges, Annual report, Ministry of Local Governments, Gaborone.

Ellis, F. and Freeman, H.A. (2005). Conceptual framework and overview of themes. In: F. Ellis and H.A. Freeman (Eds). Rural livelihoods and poverty reduction policies. Routledge, London

FAO (2005). Increasing the contribution of small-scale fisheries to poverty alleviation and food security, FAO, Rome.

Government of Botswana (2003). Ngamiland district settlement strategy (2003-2007): A report survey, Government of Botswana

Gumbricht, T., Wolski, P., Frost, P. and McCarthy. T.S. (2004). Forecasting the Spatial Extent of the Annual Flood in the Okavango Delta, Botswana. *Journal of Hydrology,* 290:178-191.

Kgathi, D.L., Mmopelwa, G., Stone, L and Thaga, K. (2008). Recreational Use Value of Nature-based Tourism and Willingness to Pay for Conservation of biodiversity in the Okavango Delta, Botswana: Implications for Policy. A Report Submitted to the BIOKAVANGO PROJECT

Kgathi, D.L., Mmopelwa, G. and Mosepele, K. (2005). Natural resources assessment in the Okavango Delta, Botswana: Case studies of some key resources. Natural Resources Forum 29:70-81

Kgathi, D. L., Kniveton, D., Ringrose, S., Turton, A.R., Vanderpost, C.H.M., Lundqvist, J., Seely, M. (2006). The Okavango; a river supporting its people, environment and economic development, Journal of Hydrology 331: 3-17

Kgathi, D.L., Bendsen, H., Blaike, P., Mbaiwa, J., Ngwenya, B.N. & Wilk, J. (2004). *Rural livelihoods, indigenous knowledge systems, and political economy of access to natural resources in the Okavango Delta*. Maun: Harry Oppenheimer Okavango Research Centre, University of Botswana

Kwerepe, R.M. (1995). Status of Agricultural Activities in Botswana's Wetlands. In: Masundire, H.M. Eyeson, K.M. and Mpuchane, S.F. (eds) Proceedings of a Conference on Wetlands Management in Botswana, 14-16 November, Wetlands Coordinating Committee

Krantz, L. (2001). The sustainable livelihood approach to poverty reduction; An introduction. Swedish International Development Cooperation Agency (SIDA)

Masundire, H., Ringrose, S., Sefe, F.T.K. and Van der Post, C. (1998). Botswana Wetlands Policy and Strategy: Inventory of Wetlands of Botswana. National Conservation Strategy Agency. Ministry of Local Government, Lands and Housing, Gaborone.
Mbaiwa, J. (2002). The Socio Economic and Environmental Impacts of tourism Development in the Okavango Delta, Botswana, A Baseline Study. Harry Oppenheimer Okavango Research Centre, University of Botswana.

Mbaiwa, J.E. (2004a). The socio cultural impacts of tourism development in the Okavango Delta, Botswana. Journal of Tourism and Cultural Change, 2(3) 163-184)

Mbaiwa, J.E. (2004b). The socio economic benefits and challenges of community based safari hunting tourism in the Okavango Delta, Botswana. The Journal of Tourism Studies, 15(2) 37-50

Mmopelwa, G. and Blignaut, J.N. (2006).The Okavango Delta: The value of tourism. South African Journal of Economic and Management Sciences, 9(1): 113-127

Mmopelwa, G. and Ngwenya, B.N. (2008a) Socio economic distribution of benefits from fishery and other key resources in the Panhandle area of the Okavango Delta, Botswana. A report submitted to the BIOKAVANGO Project

Mmopelwa, G., Ngwenya, B.N and Bathusi, S. (2008). *The Dynamics of Subsistence fishing as a safety net in the Okavango Delta, Botswana.* pp 141 – 151 In: A. Ahmed (editor), Managing Science and Technology for a Sustainable Future. World Association for Sustainable Development (WASD).

Mmopelwa, G. (2006). The value of the Okavango delta: A natural resource accounting approach. A Thesis submitted in partial fulfillment of the requirement for the Degree of Doctor of Philosophy. In the Faculty of Natural and Agricultural Sciences. University of Pretoria

Mmopelwa, G., Mosepele, K. Mosepele,B. and Moleele, N. and Ngwenya, B. (2009). Environmentalvariability and the fishery dynamics of the Okavango Delta, Botswana: The case of subsistence fishing (African Journal of Ecology, **47**(1):1-9

Mmopelwa, G. and Ngwenya, B. (2008b). An analysis of the fishing market in the Panhandle area of the Okavango Delta. A report of the Biokavango project (Building Local Capacity for the Conservation of and Sustainable Utilization of Biodiversity. *32 pages.*

Mmopelwa, G. (2006). The value of the Okavango delta: A natural resource accounting approach. A Thesis submitted in partial fulfillment of the requirement for the Degree of Doctor of Philosophy. In the Faculty of Natural and Agricultural Sciences. University of Pretoria

Mmopelwa, G, Kgathi D.L and Molefhe, L., (2007). Tourists' perceptions and their willingness to pay for park fees: A case study of self drive and clients for mobile tour operators in Moremi Game Reserve, Botswana, *Tourism Management,* 28 (4), 1044-1056.

Mmopelwa, G., Raletsatsi, S. and Mosepele, K. (2005). Cost benefit analysis of commercial fishing in Shakawe, Ngamiland, Botswana Notes and Records 37: 11-21

Mosepele, K. (2001). Preliminary Description of the Okavango Delta Fishery. Fisheries Section, Ministry of Agriculture, Gaborone.

Mosepele, K., Mmopelwa, T.G. and Mosepele B. (2003). Characterization and Monitoring of the Okavango Delta artisanal fishery. In Bernard T., Mosepele, K and Ramberg L. (Eds), Environmental Monitoring of tropical and sub-tropical wetlands, University of Botswana, Maun, and University of Florida, Gainesville, FLA

Mosepele, K., Mmopelwa, G., Mosepele, B. and Kgathi, D.L. (2007). *Indigenous Knowledge and Fish Utilisation in the Okavango Delta: Implications for Food Security*, pp 292-302. In: A. Ahmed (Ed), Managing knowledge, Technology and Development in the Era of Information Revolution World Association for Sustainable Development (WASD).

Neme, L.A. (1997). The Power of the few: Bureaucratic Decision Making in the Okavango Delta. *The Journal of Modern African Studies*, 35 (1):37-51.

Nyepi, M.S., Ngwenya, B.N. and Majelantle, R. (2008). *Assessment of food insecurity and dietary diversity in the Okavang Delta and the potential contribution of indigenous foods* pp 121 – 130 In: A. Ahmed (editor), Managing Science and Technology for a Sustainable Future. World Association for Sustainable Development (WASD).

Okavango Delta Management Plan (2006). Draft final Okavango Delta Management Plan, Department of Environmental Affairs. Gaborone

Ouma, E.A., Obare, G.A., and Staal, S.J (2004). The socio economic dimensions of small holder livestock management in Kenya and its effects on competitiveness of crop-livestock System (Paper 76__1). Paper contributed to the Naro Conference on Integrated Agricultural Research for Development-Achievement, Lessons Learnt and best practices to be held at Kampala, Uganda

Pearce, D.W. and Turner, R.K. (1990). *Economics of Natural Resources and the Environment,* Harvester Wheatsheaf, New York.

Randeli, R (2003). An economic assessment of the value of cattle to rural communities in the former Venda region. *Development Southern Africa* 20(1): 89-103

Rothert, S. (1997). Which Way the Okavango Delta? In Proceedings of a National Conference on Conservation and Management of Wildlife in Botswana: Strategies for the Twenty First century 13th-17th October 1997, Department of Wildlife and National Parks and Kalahari Conservation Society, Gaborone.

Scoones, I. (1998). Sustainable Rural Livelihood: A framework for Analysis. IDS Working Paper No. 72. IDS, Brighton, UK

Silvius, M.J., Oneka, M. and Verhagen, A. (2000). Wetlands: Lifeline for the People at the Edge. *Physics, Chemistry and Earth,* 25 (7-8): 645-652.

Shackleton, C., Shackleton, S., Gambiza, J., Nel E., Rowntree, K. and Urquhart, P. (2008). Links between ecosystem services and poverty alleviation: Situation analysis for arid and semi arid land in southern Africa. Available from: http://www.unpei.org/PDF/preliminaryassessments/Links-Ecosystem-Services-and-Poverty-Alleviation.pdf (Date accessed 10th Feb, 2009)

Terry, M. E. (1999). The economic and social significance of the handicraft industry in Botswana. PhD Thesis, School of Oriental and African Studies, University of London.

Turner, R.K., Jeroen, C.J.M., v.d Berg., Soderrqvist. T., Barendregt, A., Straten, J.v.d., Maltby, E., van Ireland, E.K. (2000). Ecological Economic Analysis of Wetlands: Scientific integration for management and policy. *Ecological Economics,* 35 (1):7-23

Turpie, J., Barnes, J., Arntzen, A., Nherera, B., Lamge G-M and Buzwane B. (2006). Economic value of the Okavango Delta, Botswana and implications for management Republic of Botswana Winpenny, J.T. (1991), *Values for the Environment: A guide for Economic Appraisal.* Overseas Development Institute, London.

Welcome, R.L. (1985). River fisheries. FAO, Rome,

Van der Duim, R and Henkens, R. (2007). Wetlands, poverty reduction and sustainable tourism development, opportunities and constraints. Wetlands International, The Netherlands.

World Food Summit (1996). Five years' later, FAO, Rome.

Winpenny, J.T. (1991). *Values for the Environment: A guide for Economic Appraisal.* Overseas Development Institute, London.
Government of Botswana, 2003)

Wilk, J. and Kgathi .D.L (2007). Risk in the Okavango Delta in the face of social environmental change. GeoJournal, 70(2): 121-132

World Bank (2000). World Development Report : Attacking poverty: Opportunity, empowerment, and security. http://siteresources.worldbank.org/INTPOVERTY/Resources/WDR/overview.pdf

The Okavango River Basin Transboundary Diagnostic Analysis Technical Reports

In 1994, the three riparian countries of the Okavango River Basin – Angola, Botswana and Namibia – agreed to plan for collaborative management of the natural resources of the Okavango, forming the Permanent Okavango River Basin Water Commission (OKACOM). In 2003, with funding from the Global Environment Facility, OKACOM launched the Environmental Protection and Sustainable Management of the Okavango River Basin (EPSMO) Project to coordinate development and to anticipate and address threats to the river and the associated communities and environment. Implemented by the United Nations Development Program and executed by the United Nations Food and Agriculture Organization, the project produced the Transboundary Diagnostic Analysis to establish a base of available scientific evidence to guide future decision making. The study, created from inputs from multi-disciplinary teams in each country, with specialists in hydrology, hydraulics, channel form, water quality, vegetation, aquatic invertebrates, fish, birds, river-dependent terrestrial wildlife, resource economics and socio-cultural issues, was coordinated and managed by a group of specialists from the southern African region in 2008 and 2009.

The following specialist technical reports were produced as part of this process and form substantive background content for the Okavango River Basin Transboundry Diagnostic Analysis

Final Study Reports	*Reports integrating findings from all country and background reports, and covering the entire basin.*		
		Aylward, B.	*Economic Valuation of Basin Resources: Final Report to EPSMO Project of the UN Food & Agriculture Organization as an Input to the Okavango River Basin Transboundary Diagnostic Analysis*
		Barnes, J. et al.	*Okavango River Basin Transboundary Diagnostic Analysis: Socio-Economic Assessment Final Report*
		King, J.M. and Brown, C.A.	*Okavango River Basin Environmental Flow Assessment Project Initiation Report (Report No: 01/2009)*
		King, J.M. and Brown, C.A.	*Okavango River Basin Environmental Flow Assessment EFA Process Report (Report No: 02/2009)*
		King, J.M. and Brown, C.A.	*Okavango River Basin Environmental Flow Assessment Guidelines for Data Collection, Analysis and Scenario Creation (Report No: 03/2009)*
		Bethune, S. Mazvimavi, D. and Quintino, M.	*Okavango River Basin Environmental Flow Assessment Delineation Report (Report No: 04/2009)*
		Beuster, H.	*Okavango River Basin Environmental Flow Assessment Hydrology Report: Data And Models(Report No: 05/2009)*
		Beuster, H.	*Okavango River Basin Environmental Flow Assessment Scenario Report : Hydrology (Report No: 06/2009)*
		Jones, M.J.	*The Groundwater Hydrology of The Okavango Basin (FAO Internal Report, April 2010)*
		King, J.M. and Brown, C.A.	*Okavango River Basin Environmental Flow Assessment Scenario Report: Ecological and Social Predictions (Volume 1 of 4)(Report No. 07/2009)*
		King, J.M. and Brown, C.A.	*Okavango River Basin Environmental Flow Assessment Scenario Report: Ecological and Social Predictions (Volume 2 of 4: Indicator results) (Report No. 07/2009)*
		King, J.M. and Brown, C.A.	*Okavango River Basin Environmental Flow Assessment Scenario Report: Ecological and Social Predictions: Climate Change Scenarios (Volume 3 of 4) (Report No. 07/2009)*
		King, J., Brown, C.A., Joubert, A.R. and Barnes, J.	*Okavango River Basin Environmental Flow Assessment Scenario Report: Biophysical Predictions (Volume 4 of 4: Climate Change Indicator Results) (Report No: 07/2009)*
		King, J., Brown, C.A. and Barnes, J.	*Okavango River Basin Environmental Flow Assessment Project Final Report (Report No: 08/2009)*
		Malzbender, D.	*Environmental Protection And Sustainable Management Of The Okavango River Basin (EPSMO): Governance Review*
		Vanderpost, C. and Dhliwayo, M.	*Database and GIS design for an expanded Okavango Basin Information System (OBIS)*
		Veríssimo, Luis	*GIS Database for the Environment Protection and Sustainable*

			Management of the Okavango River Basin Project
		Wolski, P.	*Assessment of hydrological effects of climate change in the Okavango Basin*
Country Reports Biophysical Series	***Angola***	*Andrade e Sousa, Helder André de*	*Análise Diagnóstica Transfronteiriça da Bacia do Rio Okavango: Módulo do Caudal Ambiental: Relatório do Especialista: País: Angola: Disciplina: Sedimentologia & Geomorfologia*
		Gomes, Amândio	*Análise Diagnóstica Transfronteiriça da Bacia do Rio Okavango: Módulo do Caudal Ambiental: Relatório do Especialista: País: Angola: Disciplina: Vegetação*
		Gomes, Amândio	*Análise Técnica, Biofísica e Socio-Económica do Lado Angolano da Bacia Hidrográfica do Rio Cubango: Relatório Final:Vegetação da Parte Angolana da Bacia Hidrográfica Do Rio Cubango*
		Livramento, Filomena	*Análise Diagnóstica Transfronteiriça da Bacia do Rio Okavango: Módulo do Caudal Ambiental: Relatório do Especialista: País: Angola: Disciplina:Macroinvertebrados*
		Miguel, Gabriel Luís	*Análise Técnica, Biofísica E Sócio-Económica do Lado Angolano da Bacia Hidrográfica do Rio Cubango: Subsídio Para o Conhecimento Hidrogeológico Relatório de Hidrogeologia*
		Morais, Miguel	*Análise Diagnóstica Transfronteiriça da Bacia do Análise Rio Cubango (Okavango): Módulo da Avaliação do Caudal Ambiental: Relatório do Especialista País: Angola Disciplina: Ictiofauna*
		Morais, Miguel	*Análise Técnica, Biófisica e Sócio-Económica do Lado Angolano da Bacia Hidrográfica do Rio Cubango: Relatório Final: Peixes e Pesca Fluvial da Bacia do Okavango em Angola*
		Pereira, Maria João	*Qualidade da Água, no Lado Angolano da Bacia Hidrográfica do Rio Cubango*
		Santos, Carmen Ivelize Van-Dúnem S. N.	*Análise Diagnóstica Transfronteiriça da Bacia do Rio Okavango: Módulo do Caudal Ambiental: Relatório de Especialidade: Angola: Vida Selvagem*
		Santos, Carmen Ivelize Van-Dúnem S.N.	*Análise Diagnóstica Transfronteiriça da Bacia do Rio Okavango:Módulo Avaliação do Caudal Ambiental: Relatório de Especialidade: Angola: Aves*
	Botswana	*Bonyongo, M.C.*	*Okavango River Basin Technical Diagnostic Analysis: Environmental Flow Module: Specialist Report: Country: Botswana: Discipline: Wildlife*
		Hancock, P.	*Okavango River Basin Technical Diagnostic Analysis: Environmental Flow Module : Specialist Report: Country: Botswana: Discipline: Birds*
		Mosepele, K.	*Okavango River Basin Technical Diagnostic Analysis: Environmental Flow Module: Specialist Report: Country: Botswana: Discipline: Fish*
		Mosepele, B. and Dallas, Helen	*Okavango River Basin Technical Diagnostic Analysis: Environmental Flow Module: Specialist Report: Country: Botswana: Discipline: Aquatic Macro Invertebrates*
	Namibia	*Collin Christian & Associates CC*	*Okavango River Basin: Transboundary Diagnostic Analysis Project: Environmental Flow Assessment Module: Geomorphology*
		Curtis, B.A.	*Okavango River Basin Technical Diagnostic Analysis: Environmental Flow Module: Specialist Report Country: Namibia Discipline: Vegetation*
		Bethune, S.	*Environmental Protection and Sustainable Management of the Okavango River Basin (EPSMO): Transboundary Diagnostic Analysis: Basin Ecosystems Report*
		Nakanwe, S.N.	*Okavango River Basin Technical Diagnostic Analysis: Environmental Flow Module: Specialist Report: Country: Namibia: Discipline: Aquatic Macro Invertebrates*
		Paxton, M.	*Okavango River Basin Transboundary Diagnostic Analysis: Environmental Flow Module: Specialist Report:Country:Namibia: Discipline: Birds (Avifauna)*
		Roberts, K.	*Okavango River Basin Technical Diagnostic Analysis: Environmental Flow Module: Specialist Report: Country: Namibia: Discipline: Wildlife*

		Waal, B.V.	*Okavango River Basin Technical Diagnostic Analysis: Environmental Flow Module: Specialist Report: Country: Namibia:Discipline: Fish Life*
Country Reports Socioeconomic Series	***Angola***	*Gomes, Joaquim Duarte*	*Análise Técnica dos Aspectos Relacionados com o Potencial de Irrigação no Lado Angolano da Bacia Hidrográfica do Rio Cubango: Relatório Final*
		Mendelsohn, .J.	*Land use in Kavango: Past, Present and Future*
		Pereira, Maria João	*Análise Diagnóstica Transfronteiriça da Bacia do Rio Okavango: Módulo do Caudal Ambiental: Relatório do Especialista: País: Angola: Disciplina: Qualidade da Água*
		Saraiva, Rute et al.	*Diagnóstico Transfronteiriço Bacia do Okavango: Análise Socioeconómica Angola*
	Botswana	*Chimbari, M. and Magole, Lapologang*	*Okavango River Basin Trans-Boundary Diagnostic Assessment (TDA): Botswana Component: Partial Report: Key Public Health Issues in the Okavango Basin, Botswana*
		Magole, Lapologang	*Transboundary Diagnostic Analysis of the Botswana Portion of the Okavango River Basin: Land Use Planning*
		Magole, Lapologang	*Transboundary Diagnostic Analysis (TDA) of the Botswana p Portion of the Okavango River Basin: Stakeholder Involvement in the ODMP and its Relevance to the TDA Process*
		Masamba, W.R.	*Transboundary Diagnostic Analysis of the Botswana Portion of the Okavango River Basin: Output 4: Water Supply and Sanitation*
		Masamba,W.R.	*Transboundary Diagnostic Analysis of the Botswana Portion of the Okavango River Basin: Irrigation Development*
		Mbaiwa.J.E.	*Transboundary Diagnostic Analysis of the Okavango River Basin: the Status of Tourism Development in the Okavango Delta: Botswana*
		Mbaiwa.J.E. & Mmopelwa, G.	*Assessing the Impact of Climate Change on Tourism Activities and their Economic Benefits in the Okavango Delta*
		Mmopelwa, G.	*Okavango River Basin Trans-boundary Diagnostic Assessment: Botswana Component: Output 5: Socio-Economic Profile*
		Ngwenya, B.N.	*Final Report: A Socio-Economic Profile of River Resources and HIV and AIDS in the Okavango Basin: Botswana*
		Vanderpost, C.	*Assessment of Existing Social Services and Projected Growth in the Context of the Transboundary Diagnostic Analysis of the Botswana Portion of the Okavango River Basin*
	Namibia	*Barnes, J and Wamunyima, D*	*Okavango River Basin Technical Diagnostic Analysis: Environmental Flow Module: Specialist Report: Country: Namibia: Discipline: Socio-economics*
		Collin Christian & Associates CC	*Technical Report on Hydro-electric Power Development in the Namibian Section of the Okavango River Basin*
		Liebenberg, J.P.	*Technical Report on Irrigation Development in the Namibia Section of the Okavango River Basin*
		Ortmann, Cynthia L.	*Okavango River Basin Technical Diagnostic Analysis: Environmental Flow Module : Specialist Report Country: Namibia: discipline: Water Quality*
		Nashipili, Ndinomwaameni	*Okavango River Basin Technical Diagnostic Analysis: Specialist Report: Country: Namibia: Discipline: Water Supply and Sanitation*
		Paxton, C.	*Transboundary Diagnostic Analysis: Specialist Report: Discipline: Water Quality Requirements For Human Health in the Okavango River Basin: Country: Namibia*

Environmental protection and sustainable management of the Okavango River Basin

EPSMO

Cuito Cuanavale, Angola

Republic of Botswana

GLOBAL ENVIRONMENT FACILITY
INVESTING IN OUR PLANET

Sida

OKACOM

Tel +267 680 0023 Fax +267 680 0024 Email okasec@okacom.org www.okacom.org
PO Box 35, Airport Industrial, Maun, Botswana