Okavango River Basin Transboundary Diagnostic Analysis Technical Report

OKACOM

The Permanent Okavango River Basin Water Commission

Okavango River Basin Transboundary Diagnostic Analysis: Socio-Economic Assessment
Final report

J. Barnes. et al.

September 2009

Environmental protection and sustainable management of the Okavango River Basin

EPSMO

SOCIOECONOMIC SERIES

Okavango River Basin Transboundary Diagnostic Analysis: Socio-Economic Assessment

Final report

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AIDS	Acquired immune deficiency syndrome
ADB	African Development Bank
CBNRM	Community-based natural resource management
EFA	Environmental flows assessment
EPSMO	Environmental Protection and Sustainable Management of the Okavango River Basin Project
FAO	Food and Agriculture Organisation of the United Nations
GDP	Gross domestic product
GEF	Global Environment Facility
GEP	Gabinete de Estudos e Planeamentos
GNI	Gross national income
GNP	Gross national product
HDI	Human development index
HIV	Human immunodeficiency virus
IUA	Integrated unit of analysis
MET	Ministry of Environment and Tourism
NGO	Non-governmental organisation
ODMP	Okavango Delta Management Plan
OKACOM	Permanent Okavango River Basin Water Commission
PAGSO	Projecto de Protecção Ambiental e Gestão Sustentável da Bacia Hidrográfica do Okavango
PRB	Population Reference Bureau
SAM	Social accounting matrix
TDA	Transboundary diagnostic analysis
UNHDR	United Nations Human Development Reports

1. Introduction

This document reports on the socio-economic assessment for the transboundary diagnostic assessment (TDA) of the Okavango River Basin. It forms one of the key supporting documents for the TDA.

The tasks of the socio-economic assessment team may be described as the following:

- Delineate socio economic areas within the basin that are homogeneous in terms of livelihoods, household income and economic activity: Integrated Units of Analysis (IUAs),
- Describe the basin in terms of its demographic, cultural, health, and economic characteristics, in particular assessing the current link between river resources and HIV/AIDS,
- Assess livelihoods reliance on river and associated resources for household income for each IUA within the basin,
- Assess the economic value and economic impact of all river-related natural resource use for each IUA in the basin and its importance in terms of poverty alleviation, and development,
- Assess the impact of three examples of water use development scenarios, selected by OKACOM, on the livelihoods and economic wellbeing in the basin and its countries.

The core of the TDA has been the environmental flows assessment (EFA) through which a model of the river basin was developed. The EFA incorporated hydrological flow and flood models of the basin, which informed biophysical models reflecting conditions in the basin, which in turn informed socio-economic models assessing livelihoods and economic values in the basin. The EFA is described in detail in an accompanying background report.

The report contains sections on the approaches and methodologies used in valuation, the delineation of basin IUAs, the demography, cultural and health characteristics of the basin, the livelihood and economic values associated with river/wetland resources use, and the assessment of likely impacts on these values from water use development scenarios.

2. Methodology

The country teams collated, reviewed and summarised all available published and unpublished information on the social and economic characteristics in their parts of the basin. Other related, published and unpublished information on livelihood and economic values in similar environments and in other river systems of the southern African region was also scanned. The study drew heavily on the numerous background reports produced by country and process team members, including those of Bergman (2008), Chimbari (2009), Liebenberg (2009), Magole (2009), Masamba (2009), Mbaiwa (2009), Mbaiwa & Mmopelwa (2009), Mmopelwa (2009a, 2009b), Nashipili (2009), Ngwenya (2009), Ortmann (2009), Paxton (2009), Pereira (2009), Saraiva (2009) and Vanderpost (2009).

A rapid multidisciplinary field survey was carried out by the TDA/EFA core team, with assistance within each country from the relevant country teams. Eight target sites, three in Angola, two in Namibia, and three in Botswana, were visited to collect basic data for all disciplines. Socio-economic data was collected at these sites through focus group discussion meetings with basin community members and from key informants.

The 12 integrated units of analysis (IUAs), developed in the EFA process (described below), as relatively homogeneous socio-economic zones, were delineated based on a multidisciplinary analysis. These were used to guide data gathering, and as the basis for extrapolation and aggregation of livelihood and economic values for the present day basin.

Two specific surveys were carried out to address important data gaps. First, a detailed household and community level survey was carried out in the Angolan part of the basin. Here a stratified sample of 551 households was surveyed in accessible parts of the Angolan basin in Kuando Kubango (51%), Bié (24%), Huambo (17%), and Huíla (8%). To support the quantitative survey, qualitative assessment with focus discussion groups and participatory rural appraisal was also used. The results are presented in Saraiva (2009).

Second, a small quantitative questionnaire survey was carried out among tourism operators in the Botswana part of the basin. Here a systematic sample of 48 tourism operators, were surveyed with the aim of measuring the likely effects that river flow change, and associated flood change, might have on tourism incomes. The results of this were described by Mbaiwa & Mmopelwa (2009).

Empirical results from literature and the surveys were used to develop natural resource use and tourism enterprise models. These formed the basis for valuation. Most of the enterprise models were adapted from those developed during a recent, detailed valuation of wetland values in the Okavango delta (Turpie et al. 2006).The economic analysis for the EFA model was focused only on the river and wetland values, i.e., those values that could be affected by *flow change*. These included values for household use of river-based natural resources such as fish, reeds, floodplain grass, floodplain gardens and floodplain grazing, as well as commercial river- and floodplain-based tourism. For the TDA as a whole, the value of all natural resource uses including those making up water use development scenarios within the active basin were included. Figure 2.1 shows how river resources are embedded in and linked to broader basin resources.

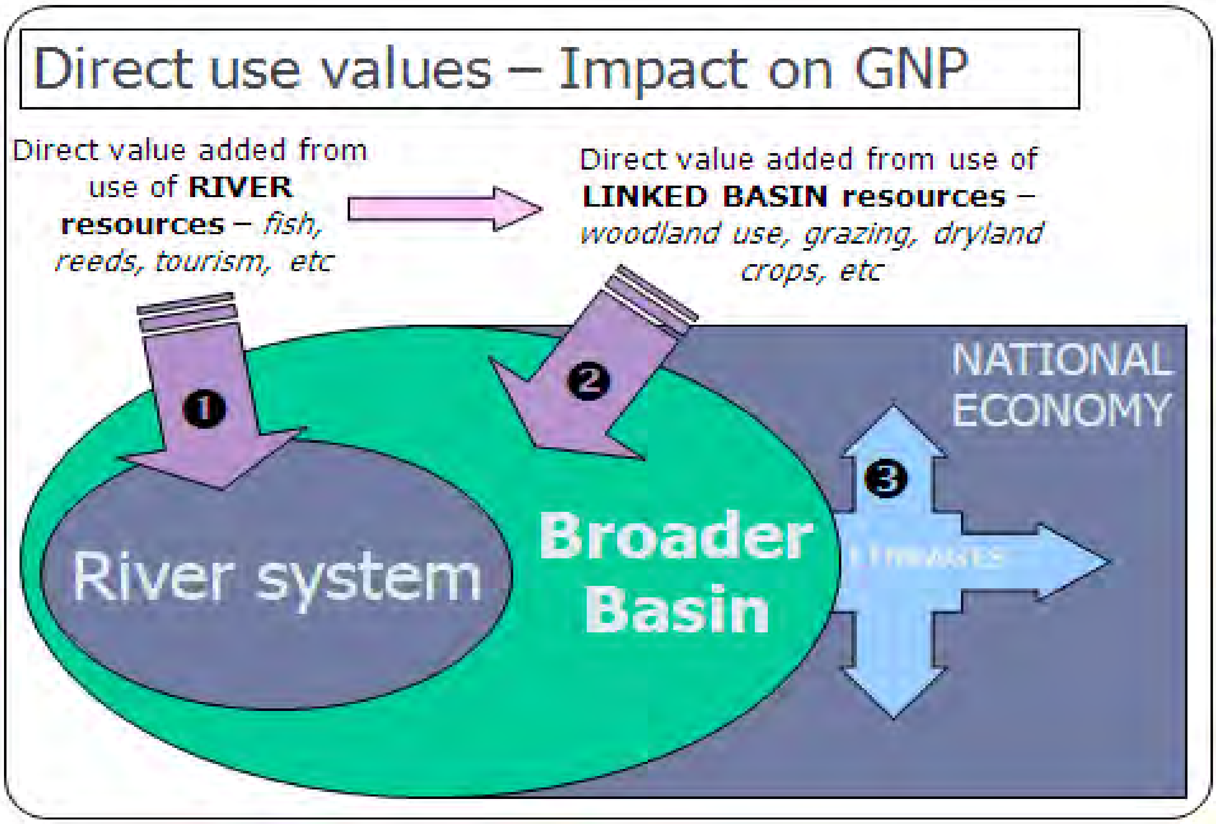

Figure 2. 1: Depiction of economic values: direct river system values considered for the EFA (1), additional broader basin direct values considered for the TDA (2), and indirect linked values in the national economy (3)

The economic analyses measured the *private* wellbeing of the basin inhabitants, as well as the *national* wellbeing of the basin countries. Private wellbeing was measured as the net change in household livelihoods. This is the net gain in welfare, due to the resources of the river basin and its functions, experienced by households. It is the net profits earned by households in their income-earning activities. Private wellbeing as affected by intangible factors such as water quality was subjectively assessed, but not included in livelihood measures. National wellbeing was measured as the direct net change in *national income*. In this case the enterprise models were used to measure the value added to the national income by the enterprise (see box). The specific national income measure used was *gross national product*.

Measurement of the direct contribution to the national income was extended to illustrate the total direct *and indirect* impact of resource use the on national economies (Figure 2.1). This was done using multipliers calculated from social accounting matrix (SAM) models (Lange et al. 2004; Turpie et al. 2006). National wellbeing as affected by *indirect use values,* or ecosystem services, was also measured in terms of national income. National wellbeing as affected by *non-use value* (existence, bequest and option value) was assessed in terms of willingness to pay for preservation at local, national and international levels.

In all valuation work, values were first estimated in the national currency concerned and then converted to United States Dollars (US$ or USD) to allow comparison. Exchange rates applied were those encountered in 2008, where *US$1.00 was worth 75.20 Angolan Kwanza (Kz or AKZ), 8.16 Namibia Dollars (N$ or NAD), and 7.16 Botswana Pula (P or BWP).*

Box 1: What is the difference between private and national wellbeing?

Private values effectively measure how the *investor*, in the basin context usually a household, loses or benefits from natural resource use. This means his/her *net gain* from the activity in terms of either own consumption or money. Thus a fisher household acquires fishing gear, makes annual expenditures in time, bait and repairs to gear, and catches fish, either to eat or sell. The difference between the annual value of fish caught and the annual fishing and capital depreciation costs is the *annual profit or loss* (the private livelihood value of fishing). Similarly, in a larger tourism lodge investment the investor builds a lodge, buying all equipment and vehicles needed. He spends annually on fuel, food for guests, staff wages, and capital depreciation of loan repayments, and earns income though guest tariffs. The difference between income and expenditures is the net profit of the enterprise.

National values effectively measure how the *national economy* gains or loses from the natural resource use activity. This means the change in *all income*, and not just the profit/loss of the private investor. Thus in a tourism lodge enterprise, income may be earned by the investor as net profit, the employees as salaries and wages, the owners of any loan capital invested as interest, the landholders as rentals, and the government through various taxes and levies. All these income categories constitute the value added by the enterprise. National income is the aggregate of all the value added in all the production units of the economy. National wellbeing is measured as the direct net change in *national income*. The specific national income measure used is *gross national product*.

3. Basin delineation and socio-economic indicators

Table 3.1 describes 14 zones within the basin, identified as being homogeneous socio-economically. During the environmental flows analysis (EFA), these were reconciled with biophysical zones, which had been similarly defined by the biophysical working groups, to create a map with 12 integrated units of analysis (IUAs). Figure 3.1 shows the schematic layout of these consolidated IUAs as delineated in the basin. The process is described by Bethune et al. (2009).

Angolan IUAs 1 to 4 were delineated in the Cubango arm of the basin. In the Cubango arm, floodplains are rare and river courses are relatively incised. The basement geology has mostly been exposed, leaving little Kalahari sand cover. The IUAs here were delineated on the basis of topography, ecology, population density, urbanisation and the future likely water use developments. Thus, IUA 1 covers the high rainfall, high altitude upper reaches where parallel tributaries drain an open upland savanna, the soils are medium textured, and there is a high density of people. Rainfed crop production with maize is the most important land use. IUA 2, including the town of Cuchi, is similar but lower, less incised, slightly drier, slightly less densely settled and it contains small areas of Kalahari sand woodlands. It contained field study site 2, at Mucundi. IUA 3 is specific to the Cuebe river catchment and includes the city of Menongue. Here the situation is similar to that of IUA 2 but there are some water quality issues surrounding the city, and there is some irrigation of crops and plans for much more. The field study site 1 at Capico was included here.

Angolan IUAs 5 to 7 were delineated for the Cuito arm of the basin. These are relatively uninhabited, pristine, and occupied by Kalahari sand woodlands. Floodplains are more significant here than in the Cubango arm, and water flow variation is much more seasonally stable. The three IUAs here were separated on the grounds of rainfall (from humid to semi-arid), on the basis of crops grown (cassava is the main crop grown in the upper part), the presence of an urban area (Cuito Cuanavale) and on the basis of future water use developments (likely to be in the lower reaches). Field study site 3 at Cuito, was situated in IUA 6.

Zone	Country	River	Description	Basic characteristics	Additional features
1	Angola	Cubango	Upper Cubango reaches from source to line between Kubango and Mumbué	Dense population, dryland maize dominated subsistence production few livestock	-
2	Angola	Cubango	Central Cubango from Kubango to line between Mucundi and Machai	Moderate population maize and millet few livestock. Some fish use, charcoal production.	Several urban zones, irrigation potential, direct water use
3	Angola	Cubango	Lower Cubango from Mucundi to riverine zone below Catamoué	Inactive basin low population millet some livestock	-
4	Angola	Cuito	Upper Cuito from source to 14^0 latitude	Low population, mandioca production no livestock.	Some timber potential
5	Angola	Cuito	Central Cuito from 14^0 latitude to 16^0 latitude	Low population, millet and few livestock.	Some urban development, timber potential.
6	Angola	Cuito	Lower Cuito from16^0 latitude to confluence with Cubango	Low population millet few livestock some timber potential. Flood attenuation. Some timber production	Some tourism potential
7	Angola/ Namibia	Cubango/ Okavango	Immediate terraces of river in Angola and Botswana from Catamoué to Divundu	110,000 people. Dense population in riparian strip. Millet production with livestock fishing (53% of people) and some plant use. Irrigation development. Aquaculture.	One large urban centre (Rundu) and associated tourism. Trans border movement.
8	Namibia	Okavango	Protected areas, Mahango Game reserve, Bwabwata National Park and conservancies	Tourism, biodiversity protection, Some use of upland and wetland plant resources.	Tourism potential
9	Botswana	Okavango	Panhandle from Mohembo to Seronga. Permanently flooded wetlands	25,000 people. Wetland plants use (20%) and fish use (11%) important in natural resource use. Dryland millet production (9%), livestock (45%) and upland plants use (15%) also important.	River- based tourism (mainly angling) fairly important. Potential for wildlife –based tourism.
10	Botswana	Okavango Delta	Western edge of Delta, west of Buffalo fence, from Ikoga to 10km south of Nokaneng.	17,000 people. Wetland plants use (9%), Molapo crop production (6%) fairly important in Natural resource use. Livestock (74%) and upland plant use (10%) important.	Some Delta-based tourism.
11	Botswana	Okavango Delta	South western edge of Delta SW from Buffalo fence, between 10km south of Nokaneng to 10 km west of Komana.	9,200 people. Limited wetland resource use Wetland plants (4%) Molapo crops (1%), mainly in Xudum, Thamalakane channels. Livestock (81%) very important, upland plants (11%) fairly important.	-
12	Botswana	Okavango Delta	South eastern edge of Delta from 10km west of Komana to the Buffalo fence in north west and north.	53,500 people (including Maun). Wetland plants (12%) and fish (1%) and Molapo crops (2%) of natural resources use. Livestock important (64%) and upland plants (17%) fairly important. Tourism directed at Delta very important.	Includes urban centre of Maun.
13	Botswana	Okavango Delta	Central Delta north and east of the Buffalo fence.	1,500 people. Delta based tourism extremely important. Small human population makes important use of wetland resources. Fish (26%), Wetland plants (20%), Molapo crops (5%). Use of upland wild resources (38%) fairly important and livestock (8%) unimportant.	Community-based natural resource use (CBNRM) important.
14	All countries	Various	Urban centres – Menongue, Rundu, Maun.	Urban centres with more than 10,000 people and peri-urban surrounds. Specific demands on river flows, pollution, etc.	-

Table 3. 1: description and characteristics of original socio-economic IUAs, which were carried forward to the consolidated IUA map (Figure 3.1)

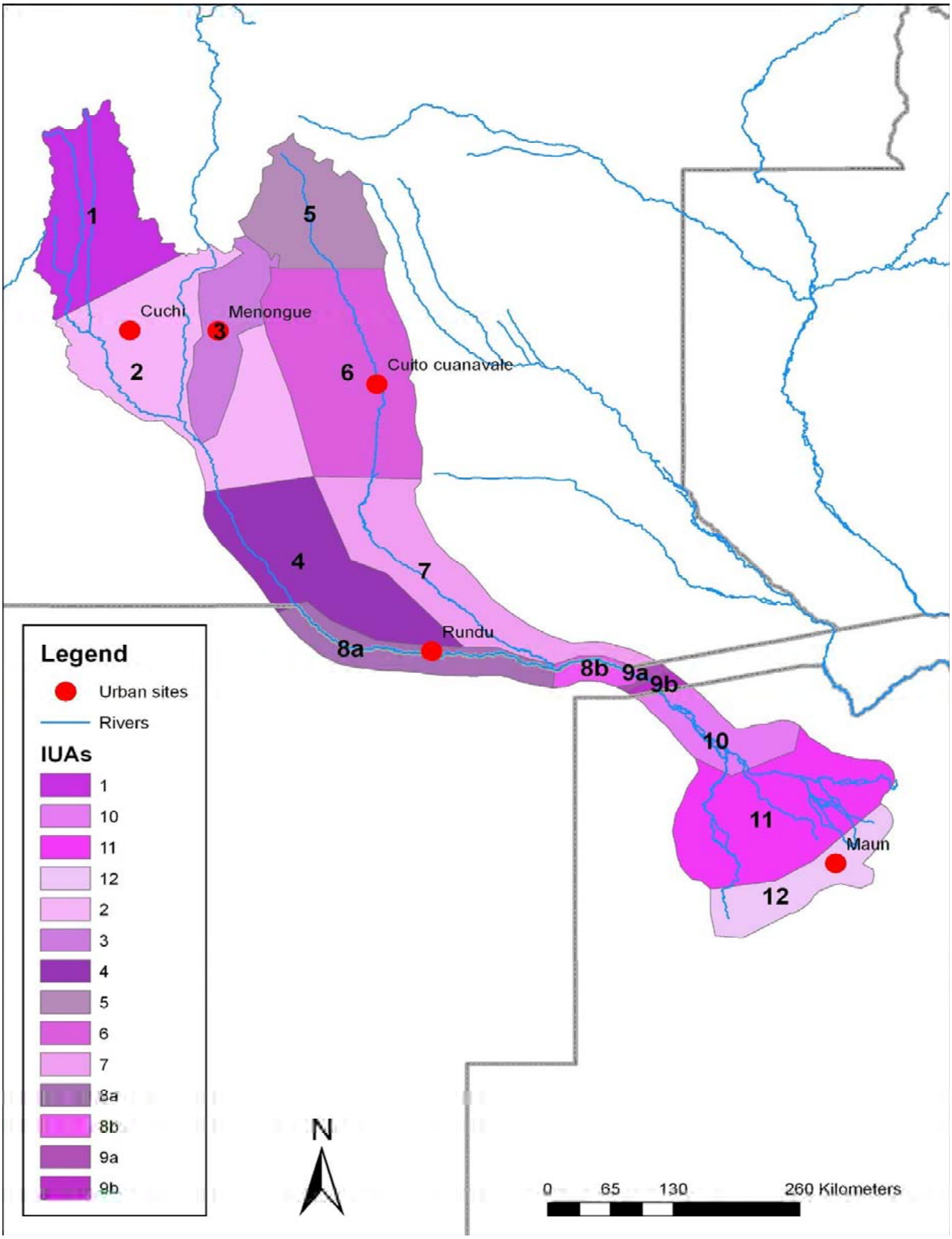

Figure 3. 1: Schematic layout of the integrated units of analysis (IUAs) in the Okavango river basin.

Two IUAs, each with two subdivisions, were defined for Namibia, based on the presence or absence of a floodplain, flooding regime, and whether or not there is a human population. IUA 8 covered the river along the Angolan border, where human population density is high and a moderate floodplain is present. It contained the urban area of Rundu, and field study site 4 at Kapako. It was subdivided between the parts above and below the Cuito junction, which differ slightly in terms of seasonal flow regime. IUA 9 covered the river below Mukwe, where a floodplain is mostly absent and some rocky exposures occur in the river bed. IUA 9 was subdivided into that section with a resident human population and that which is protected as Bwabwata National Park. It contained field study site 5 at Popa.

Three IUAs were defined for the Botswana part of the basin, based primarily of flooding patterns. IUA 10 formed the panhandle with a fairly wide, mostly permanently flooded plain and a moderately dense, relatively ethnically distinct human population. It contained field study site 6 at Mohembo. Fishing, and non-floodplain crops are characteristic. IUA 11 covered most of the Delta with a complex pattern of seasonal, permanent, frequent, and occasional flooding. It contained two subdivisions; moderately dense human settlement in the west, and natural protected areas used mostly for tourism in the north east. Filed study site 7 at Xakanaka was in the latter subdivision. IUA 12 covered the most distal part of the active basin and as such contained ephemeral channels and more restricted, less commonly flooded floodplain. Fairly dense human settlement is present here including the urban centre of Maun. It contained field study site 8 at Boteti.

The economic activities in the basin were identified and described. They were then examined and assessed to select those that might exhibit measurable value change if the river/wetland system would be subjected to flow change. These were then used as the socio-economic indicators in the EFA process. Figure 3.2 shows the full list of socio-economic indicators. Most indicators are applicable to all of the eight field study sites and 12 IUAs in the basin. The exceptions apply where, for example, there is no floodplain of significance, and thus no floodplain grazing or floodplain crop production, or where, for example, there are no resident people.

It is important to stress that the indicators selected are limited to values that are expected to change under differing water use scenarios. Some natural resource uses associated with the riverine environment provide livelihood and economic value but are unlikely to change with flow change. An example is use of riparian tree fruits, and another is irrigated commercial agricultural production. Some 2,600 hectares are irrigated in this way in the Namibian basin, contributing significant income and employment for local residents. But irrigated crop production draws water regardless of flow change. New irrigation will also form part of water use development scenarios, itself affecting water flow.

Indicator				
1. Household income - fish	Total income change as % PD	a. Household income %PD	A. SOCIAL WELL-BEING FOR LOCAL HOUSEHOLDS (=a+b+c)	C(=A+B). Overall socio-economic well-being
2. Household income - reeds				
3. Household income - floodplain grass				
4. Household income - floodplain gardens (e.g. molapo)				
5. Household income and wealth - livestock				
6. Household income - tourism				
7. Potable water/water quality		b. Potable water/water quality %PD		
8. Wellbeing/welfare from intangibles		c. Wellbeing/welfare from intangibles %Pd		
9.1 Macro effects from tourism income excluding hh (including multipliers)		d. National income (=9.1+9.2+9.3+9.4) %PD	B. ECONOMIC-WELL BEING (nationally)	
9.2 Macro effects from hh income 1-6 (including multipliers etc.)				
9.3 Indirect use				
9.4 non-use				

Figure 3 .2 List of socio-economic indicators used in the EFA and their links to the broader economy

Possible indicators affecting human wellbeing are those related to health and disease, such as malaria, bilharzia and diarrhoea were examined. These although their incidence is linked to the aquatic environment were found to not be affected specifically by flow change. Other possible indicators included natural resource uses such as water lily use (*Nymphaea* sp.) for food, and use of the sedge (*Cyperus papyrus*) for mat making, were rejected as indicators either because they were considered of small import or because in some sites their use was unlikely to be affected by flow changes. Further not all indicators have been assigned values. Where data are unavailable some relatively minor resources have been treated only in discussion, despite being recognised as possibly responsive to flow change.

The indicators in Figure 3.2 are divided firstly into those affecting both local household income, or livelihoods (indicators 1 to 8) and the broader economy, and secondly those impacting directly on the broader economy or on societal well-being (9.1 to 9.4). The table shows how these all contribute ultimately to overall social and economic wellbeing.

4. Demographic characteristics and trends

The human population in the basin is dominantly rural and, for each country, the basin populations are very remote relative to the capital and the main centres of economic activity. Table 4.1 shows some indicative figures describing the general demographic features of Angola, Namibia and Botswana, and then some specific ones for the Okavango river basin within those countries.

Table 4.1: Comparative demographic characteristics of Angola, Namibia, and Botswana (2008 unless otherwise stated)

Characteristic	Angola	Namibia	Botswana
National values			
Population	16,752,000	2,089,000	1,842,000
Population density (people/square km)	13	3	3
Birth rate (number of births per 1,000 people)	47	25	24
Death rate (number of deaths per 1,000 people)	21	15	14
Rate of natural increase (% per annum)	2.7%	1.0%	0.9%
Infant mortality rate (deaths per 1,000 live births)	132	47	44
Total fertility rate (number of children per woman)	6.8	3.6	2.9
Proportion of population aged less than 15 (%)	46%	41%	38
Urbanisation rate (% of population)	57%	35%	57%
Rate of change of urban population (2005-2010, %)	4.4%	2.9%	2.5%
Urban population living in slums (%)	86%	34%	-
Gross national Income (PPP per capita, US$)	$4,400	$5,120	$12,420
Motor vehicles (number per 1,000 people, 2000-2005)	20	-	106
Okavango river basin-specific values			
Basin population (estimated, 2008)	505,000	219,090	157,690
Basin population as proportion of national total (%)	3.0%	10.5%	8.6%
Basin households (number)	126,250	35,120	33,550
Basin household size (people)	4.0	6.2	4.7
Urbanisation rate in basin (% of population)	48%	20%	30%
Basin rural population (people)	262 600	175,270	110,630

The national level data were extracted from several websites, including UNHDR Human Development Reports (http://hdr.undp.org), World Bank Key Development Data & Statistics (http://web.worldbank.org), and Population Reference Bureau (PRB) (http://www.prb.org).

The demographic figures at country level provide useful comparison reflective generally of conditions within the basin. Angola has a population of some 17 million compared with around two million for each of Namibia and Botswana. The overall national density of people in Angola is 13 per square kilometer compared with 3 per square km for both Namibia and Botswana. This reflects the better rainfall and generally higher agricultural productivity found in most of Angola. Angola has higher birth and death rates than the others and a higher annual population growth rate (2.7%), compared with the other countries (around 1%).

Over the last 30 years, evidence suggests that Namibia and Botswana have been undergoing a demographic transition, where, due to factors such as urbanisation, female education, and generally improving household income, fertility rates and population growth rates have slowed (Mendelsohn et al. 2002; Dorrington et al. 2006). This can be explained by the fact that by most measures, social and economic development in Botswana and Namibia has been good. However, this transition has been overshadowed by the effects of a very severe HIV/AIDS pandemic which has developed in both these countries in the last 20 years. This has further reduced population growth mainly by increasing mortality rates.

Angola has experienced a much less noticeable demographic transition, with its population growth rate only very recently showing signs of slowing. This can be explained to a large extent by the fact that social and economic development has been curtailed by war. Angola has experienced high rates of urbanisation and this would normally have been a factor inducing a reduction on birth rates, but urbanisation in this case was primarily displacement due to war, and it was not accompanied by better education or higher incomes, and most of the urban populations live without services. Another difference between Angola and both Botswana and Namibia is the fact that it has not been affected to nearly the same extent as them by HIV/AIDS.

Conflicting forces appear to be at work in the demography of Botswana and Namibia and Botswana. Since the 1970s, on the one hand, improved human development indices, including reduced child mortality, have had the effect of reducing fertility. On the other hand since the 1990s HIV/AIDS has dramatically increased mortality, including child mortality. The long term result of these influences is hard to predict, but results of a rigorous study by Dorrington et al. (2006) would suggest that low population growth rates due to HIV/AIDS will persist for some time.

With the advent of peace and a resource-rich economy, Angola’s population could well be on a path towards reduced child mortality and a reduced fertility. If the current low influence of HIV/AIDS can be maintained, this could represent the start of a permanent demographic transition.

The lower part of Table 4.1 shows demographic data relevant to the basin portions of the three countries. Based on data from Saraiva (2009), it is estimated that with 505,000 people, the Angolan basin contains some 3% of the national population. Some 48% percent of this is urban, within the larger centres including Cubango, Chitembo, Mumbué, Cuchi and the largest, Menongue, with some 122,300 inhabitants. This is a lower urbanisation rate than that for the country as a whole, which is 57%, but still very high. As stated, the high urban proportion is largely the result of war. There appears to be a current tendency for people to move back to settle on rural land, but this is not rapid because most people lack the means to start farming, and there is still a threat from un-removed land mines in many areas.

Some 126,250 households are represented in the Angolan basin. The average household size is 4 persons, which small for the basin as a whole. Why this is so is not clear, given the relatively high fertility, and it may be another effect of the war. The rural population of the

Angolan part of the basin is the one most relevant to the analysis of river related resource use, below, is estimated to be 262,600, represented by some 65,650 households. Rural populations are likely to grow faster than urban ones, and so it might be expected that the growth rate in the basin has been higher than that for the nation. However, there was likely some emigration from the basin during the war. It is thought that the population growth rate in the basin has been and is growing at around 2.5% per annum. The density of the population in the Angolan basin is less than 1 person per square km, significantly lower than that for the whole country (13).

Based on data from Mendelsohn et al. (2002) and Mendelsohn & el Obied (2003), it is calculated that the Namibian part of the basin has an estimated 219,090 people, amounting to some 10.5% of its national population. Some 94% of these people live within 5 km of the river. Some 20% of them are urban, living in Rundu. This basin urbanisation rate is lower than that for the whole country, which is 35%. Household size is some 6.2 persons and thus the Namibian basin contains some 35,120 households. Most relevant to the analysis of river related resource use are the rural population and the number of rural households. These are estimated to be 175,270 and 22,600 respectively. The population density of the Namibian part of the basin is, unlike that in the rest of the basin, much higher than the national average for Namibia. This reflects the fact that the active basin here is narrow and that the fairly significant population is concentrated along the river.

Population growth rate in the Namibian basin population has been very high, up to 7% per annum between 1981 and 1991 (Mendelsohn & el Obeid 2003). This is partly due to natural increase, but mainly to immigration from Angola, for security and economic reasons during the Angolan civil war. The position has since stabilized somewhat and current and future population growth is expected to be slightly higher than that for the nation as a whole. A rate of 1.5% has been assumed to reflect future population-driven, natural resource use.

Based on data from ODMP (2008) and Dorrington et al. (2006) The Botswana part of the basin contains an estimated 157,690 people, which comprises some 8.6% of the national population. Some 30% of this urban, mostly concentrated in Maun but also in Gumare and Shakawe. This is lower than the national urbanisation rate of 57%. Average household size is some 4.7, so that some 33,550 households are present. The rural population, which primarily makes use of river and floodplain related natural resources, is estimated at 110,630, with 23,540 households. The population density in the Botswana basin was estimated by ODMP (2008) at 1.1, about one third of the national density.

Detailed analysis by Dorrington et al. (2006) indicates that the population growth in the Botswana part of the basin has been influenced by the same factors as the national one, but that the rate is slightly higher. This would make sense, given that the population is more rural. The current and future rate of growth of the Botswana basin rural population natural resource use is expected to be in the region of 1.5%. This is based on the projections of Dorrington et al. (2006), in which the effects of increasing ARV use, and change in fertility, were taken into account.

Generally, it is clear that the human populations within in the Okavango basin have many of the characteristics of the broader populations in the countries concerned. However, as can be expected in parts of those countries that are remote, they tend to be more rural, tend to have higher population growth rates, and are generally less developed.

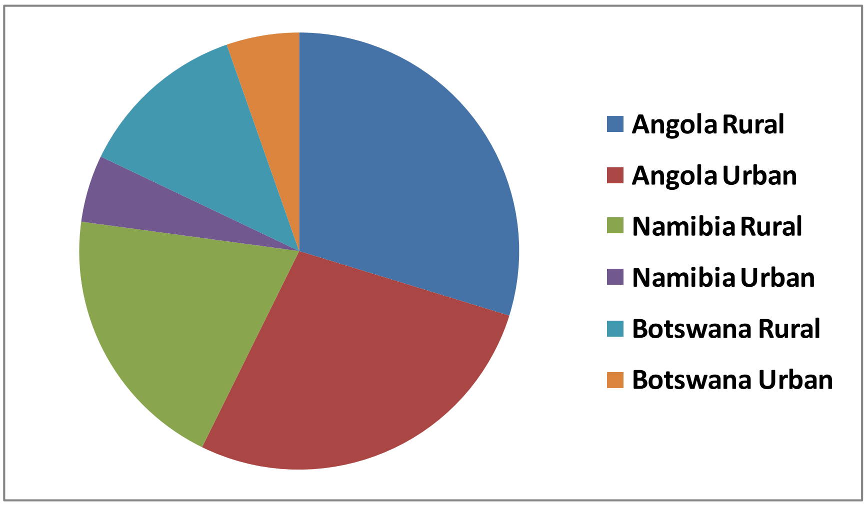

Figure 4. 1: The estimated human population in the basin (881780) by country, showing split between urban and rural

5. Social, cultural and health characteristics

In all parts of the basin outside the bigger towns, land is public, held by the state or the local traditional authorities. Households throughout practice predominantly small scale traditional land and natural resource uses. It is common for households and communities to be settled close to or on river banks or floodplain to give access to water and the richer natural resources in those setting. Significant parts of the lower basin in Botswana are protected and given over to conservation and tourism.

There are five ethno-linguistic groups within the population of the Angolan basin. The fairly densely settled Ombundo occupy the upper reaches of the Cubango. The Ganguela and Lunda-Kioko are strongly, represented in the centre of, and occupy most of, the study area. The Namibian border on the west is occupied by the Ambó, and on the east it is occupied by the Xindonga.

Five ethnic groups occupy the Namibian basin from west to east along the river. These are listed as Kwangali, Mbunza, Shambyu, Gciriku, and Mbukushu by Yaron et al. (1992). Linguistically, the first two groups, almost half the people, speak Rukangwali. The Shambyu and Gciriku speak Rumanyo, and the Mbukushu speak Thimbukushu. About a third of Rundu residents and 15% of rural inhabitants speak an Angolan language, reflecting their origin.

Ethnically the Botswana basin population is rather mixed with about seven groups, but it is dominated by the Bahambukushu in the panhandle area, the Bayeyi in the western delta, central delta, and south eastern delta, and the Batawana in the southern and eastern parts of the delta (Turpie et al. 2006).

Table 5.1 shows a selection of indicative national-level social cultural and health characteristics for Angola, Namibia and Botswana. The data were extracted and synthesised from several websites, including UNHDR Human Development Reports (http://hdr.undp.org), World Bank Key Development Data & Statistics (http://web.worldbank.org), and Population Reference Bureau (PRB) (http://www.prb.org).

Characteristic	Angola	Namibia	Botswana
National values			
Population with access to improved water sources (2006, %)	51%	93%	96%
Population using improved drinking water (urban, %)	62%	99%	100%
Population using improved drinking water (rural, %)	39%	90%	90%
Literacy rate, ages 15-24 (female, %, 2000-2004)	63%	94%	93%
Literacy rate, ages 15-24 (male, %, 2000-2004)	83%	91%	86%
High school enrolment (female, 2000-2004, % of age group)	17%	66%	75%
High school enrolment (male, 2000-2004, % of age group)	21%	59%	70%
Underweight children, age <5 (%)	28%	20%	11%
Human poverty index (HPI-1) (%) (2005)	89%	26.5%	31.4%
HIV/AIDS among adults, ages 15-49 2001 (%)	1.6%	14.6%	26.5%
HIV/AIDS among adults, ages 15-49 2007 (%)	2.1%	15.3%	23.9%
Undernourished population (2002-2004, %)	35%	24%	32%
Life expectancy at birth (years)	44	47	49
Human development index (1990)	-	0.65	0.68
Human development index (2000)	0.45	0.64	0.62
Human development index (2005)	0.48	0.63	0.66

Table 5. 1: Comparative human wellbeing, health, and human development indicators for Angola, Namibia and Botswana (2008 unless otherwise stated)

The situation in Namibia and Botswana is generally better than that in Angola. Thus only about half (51%) of Angolans have access to improved water sources, whereas that figure is between 93% and 96% in Namibia and Botswana. The access is even lower for rural Angolans. Current plans suggest that access will be improved significantly within the basin in the next few years (Administração Municipal do Cuchi 2008; Administração Municipal de Menongue 2008; GEP/Gabinete de Estudos e Planeamentos 2007; FAO/ADB Cooperative Programme 2007).

Literacy rates among 19-24 year olds in Namibia and Botswana are high at around 90% while these are lower for Angola, especially for females, at 63%. Educational enrolment among high school age people is fairly high in Namibian and Botswana at between 60% and 75%. This is much lower for Angola at around 20%. In Angola some 30% of children under 5 years of age are underweight. This measure is 20% for Namibia and 11% for Botswana. The incidence of poverty as reflected in the HPI-1 human poverty index is between 25% and 30% for Namibia and Botswana, while it is much higher for Angola at 89%.

A big difference between Angola and the other countries exists in the incidence of HIV/AIDS. Among adults it is 2.1% in Angola, but up to 15.3% Namibia and 23.9% in Botswana. The prevalence grew very fast in the latter two countries between the mid 1980s and the late 1990s (Dorrington et al. 2006). The high rate of growth has slowed, and the proportions of people infected have tended to stabilise, not increasing very much in the eight years since 2000. The infection rate in Botswana has even gone down slightly.

The effect of HIV/AIDS is to significantly increase mortality among people of reproductive age and in young children. This has had a large impact on the life expectancy at birth in

Namibia and Botswana, which has been reduced from around 60 years in the early 1990s to 47 and 49, respectively, close to that of Angola which is 44 years. The result is a significant reduction in population growth. In the last few years, the introduction of anti-retroviral treatment (ART) programmes has reduced death rates, particularly in Botswana, but this effect is only partial.

The human development index (HDI) provides a useful overall measure of how a country is meeting it Millennium Development Goals. It is calculated as an average of three indices: life expectancy, educational attainment and income. The HDIs presented in Table 3.4.2 that Namibia and Botswana both have higher values, between 62 and 66, and are classified as having medium human development, while Angola has lower ones, between 45 and 48, and is classified as having low human development. These values can be compared with the HDI for Norway, a developed country, which is 97, and that for Niger, a least developed country, which is 37.

There is an increase for Angola, between 200 and 2005, but in Namibia and Botswana there have been declines since 1995. As Levine (2007) shows for Namibia, these declines are due entirely to the effect of the HIV/AIDS epidemic which has drastically reduced life expectancy, despite marked improvements in the education and income indices. Botswana and Namibia, along with several other southern African countries (not including Angola), are unusual in that their HDIs have been declining.

The social conditions in the Okavango basin parts of Angola, Namibia and Botswana can be expected to resemble the national level ones fairly closely. In each of the three countries, partly because the river affects people differently between the countries, and partly because the countries are themselves different, the prominent social issues differ between them. Data available tend to reflect this and the discussion below thus highlights the prominent characteristics for each country.

The main differences are expected to relate to the remoteness of the basin from the national centres. In the Angolan basin, data from the recent household survey (Saraiva 2009) indicated that less than 4% of households have access to improved water supplies, much less than the 51% for the nation as a whole. The results from this survey would also suggest that households in the basin are more likely to be living in huts of wood, mud and grass, more dependent on wood and charcoal for fuel, and less likely to have access to electricity, than in the country as a whole. 54% of rural households and 14% of urban ones make use of the river system for water.

In Namibia, some good data providing comparison between the socio-economic conditions in the Okavango basin, as represented by the Kavango Region, and those at national level are available. A recent poverty analysis (CBS 2008) shows that Kavango has the highest incidence of poverty among all 13 regions in Namibia. In Kavango, 57% of households are classified as poor (with expenditure of N$262 or less per adult equivalent per month), and 36% of households are classified as severely poor (with expenditure of N$186 or less per adult equivalent per month). This can be compared with the incidence for the whole country where 27.6% of households are poor or severely poor, and 13.8% are severely poor.

In Kavango the incidence of poor among rural households (which make up 80% of the total number) is 62%, while that among the urban population (20% of the total) is only 33%.The high incidence of poverty would underline the importance of natural resources harvesting in the coping strategies of households. Government has an obligation both to target these households for poverty reduction as well as to avoid interventions which might exacerbate their poverty. Levine (2007) used a multi-dimensional human poverty index (HPI) which accounts for survival, literacy and income to show that poverty in Kavango, despite remaining the highest among the nation's regions, actually declined between 1991-1994 and 2001-2004.

The high level of poverty is associated with high dependency ratios (around 46% of the population is below 15 years, or older than 64 years, of age). Data from (Mendelsohn & el Obeid 2003) indicate that the incidence of HIV infection in the basin is slightly lower than that for most other northern regions in Namibian as well as slightly lower than for the national as a whole. Average life expectancy has declined from 57 in 1991 to 40 years in 2000, as a result of AIDS, and this has impacted negatively on the human development index (HDI), despite improvements in other HDI component measures such as education and income. This pattern is the same as that for the nation as a whole, although the national life expectancy, at 47 is slightly higher. Levine (2007) showed that the average HDI for Kavango declined from 0.48, between 1991 and 1994, to 0.41, between 2001 and 2004. As expected, the human development index (HDI) for Kavango is lower than that for Namibia as a whole. Between 2001 and 2004 the average HDI was 0.41 for Kavango, while it was 0.53 for Namibia.

High poverty levels have also contributed to high incidence of tuberculosis (TB), malaria, acute respiratory infections, diarrhoea, and urinary bilharzia, intestinal bilharzia, and malnutrition in the Namibian basin. Some of these are secondary to AIDS and increased as a result of the AIDS epidemic. Others such as malaria, which affects half the population each year, are linked to the summer rains and associated standing water. Urinary and intestinal bilharzia are water-borne diseases and both are prevalent in the river. Their incidence appears to have increased dramatically between 1990 and 2000 (Mendelsohn & el Obeid 2003).

Evidence suggests that the Botswana basin has socio-economic conditions that resemble those of the country as a whole, but that are slightly less favourable. Thus, ODMP (2008) provided data that suggest the literacy rate is lower than that for the whole country. The HIV/AIDS incidence between the basin and the country as a whole has been similar on average and has shown similar pattern.

Overall the data suggest that the Okavango basin contains people who are poorer, less healthy, and less well educated on average, than those of the countries they represent. Indeed, as described above, the Kavango region, in the Namibian part of the basin, is the poorest region in Namibia. This, given the highly unequal distribution of wealth in these countries, suggests that poverty alleviation in the basin should be a major investment target for the governments. The ambitious water use development plans inherent in the scenarios suggest that this is the case, particularly in Angola and Namibia.

Poor rural communities tend to depend on natural resources, more directly so than communities in urban centres or those involved in commercial economic activities. They commonly lack alternative ways of making a living. Hudson & Wright (1997) showed that in Botswana those in the poorest quartile depend even more than others on natural resources. Wild natural resources such as fish and wild plants, being of open access, commonly constitute 'safety nets' for poor communities in adverse times. When these natural resources decline for whatever reason, the poor commonly have few options other than to continue using them. Pressure on the resources increases and a vicious circle ensues, in which use becomes less and less sustainable and resources fall under greater and greater pressure.

Change can result from poverty through the responses of governments and others to alleviate it, but also as a result of the vulnerability of and the responses of the poor to natural resource decline.

6. Economic characteristics and values

The evidence above shows that the Okavango basin is relatively unaffected by human development. With a few exceptions ecosystem integrity has remained largely intact. This is not surprising as the basin is remote within all three countries which all have low population densities. Based on their incomes, Botswana and Namibia can be ranked as being at the lower end of the medium income category, while Angola is ranked near the upper end of the low income category. The total income and per capita income values for the three countries are shown in Table 6.1. Botswana is the richest and Angola is the poorest in terms of per capita income. The distribution of income in all three countries is uneven. They have Gini indices, measuring inequality of income, which are among the highest in the world.

Characteristic	Angola	Namibia	Botswana
National values			
Gross domestic product (US$ billion, 2007)	52.2	7.4	10.8
Gross domestic product (per capita, US$, 2007)	3,068	3,573	5,739
Unemployment rate (2006/7)	20%	34%	18%
Gini index of inequality (2007/8)	-	74.3	60.5
Natural habitat remaining	95%	>95%	90%

Table 6. 1: Some economic characteristics for Angola, Namibia and Botswana

Table 6.1 also shows a rough estimate of the amount of natural habitat remaining in each country. All countries have very high values, and this is also the case specifically within the Okavango basin.

The economic incomes generated, within the Okavango river basin, are nearly all direct use values. Resident households derive much of their income from direct use of the basin's natural resources, and this use is dominated by use of wild natural resources, such as fish, wood and grass, use of natural habitats for small scale agriculture, such as crop and livestock production, and use of natural habitats for providing tourism services. Tourism is very important in the lower parts of the basin and it earns considerable income both for households, mostly through salaries and wages, and for investors in the broader economies. Households in the lower parts of the basin earn considerable parts of their income through local employment in tourism and government, through remittances from non-local employment, and through pension payments and remittances. In a few localities in Namibia, river water is extracted for irrigation of commercial crops. The economic value of this is potentially very high, but driven down by the remoteness of the basin and the long distances from markets (Liebenberg 2009).

Fish are caught throughout the basin in river channels and on floodplains where seasonal floods can bring a marked peak in catch. Only in Botswana and only in the Panhandle area is fishing done commercially in groups of semi-motorised small scale fishers. Elsewhere fishing is small scale at household level and traditional gear (locally made traps), gill nets hook, and line and dugout canoes are used.

Households throughout the basin harvest fuelwood, poles and non-timber forest products in the form of wild plants and animals for food, medicines, and raw materials. Barnes et al. (2005) measured the value of forest use in detail for the Kavango Region which embraces the Namibian basin. It is generally not river/wetland- related, and takes place in the very extensive humid to semi-arid woodlands of the basin. One forest product that is harvested is thatch grass. Certain, specific, high quality thatch grass species are also harvested on floodplains. Reeds and sedges are harvested from the wetter parts of floodplains and riverbanks, and used for building, and craft making.

Households throughout the basin grow crops. In Angola crop production is the most important source of household income and food earning some 80% of household income (Saraiva 2009). Here the sub-humid and humid climate makes it possible to grow crops in uplands. In the lower semi-arid parts of the basin the growth of crops is carried out in both uplands and on floodplains, where additional wetness and fertility enhance yields by some 40%. Crop production is small-scale in gardens and tillage is limited largely to that by hand or by draft livestock. Very limited tractor power is available, and mainly in the Namibian and Botswana parts of the basin. In Namibia and Botswana crop production is of lesser importance for households because yields are low and losses to wildlife such as elephant can be significant.

Livestock are very important for households in the lower basin, providing a range of household utilities, such as meat, milk, draft power, and store of value. Their value further up the basin is less, mainly because many households in Angola lack stock, and the money to buy stock. The keeping of livestock is mostly small scale, household-based, and primarily subsistence in nature. Some 22% of small scale livestock-keeping value is attributable to use of floodplain grasslands where wetness enhances production. In Botswana and Namibia medium scale livestock production takes place around boreholes (cattle posts) in the uplands away from the river. The value of livestock in the Botswana basin has been studied in detail by Barnes et al. (2008).

Tourism in the Namibia and Botswana basin areas is overwhelmingly non-consumptive, nature-based, and focused on wildlife viewing, although some guided recreational fishing and hunting operations are involved. Medium to large scale lodges and camps with between 10 and 30 beds, serving middle and upper market tourists are most common. Self-drive camping and guided mobile operations are also present in significant numbers. Nearly all the value of this tourism is attributable to the presence of the river/wetlands, although the activities offered can be either land- or water-orientated. Most tourism income for local households comes through wages and salaries, but to some extent local households directly provide small-scale services, such as guided canoe trips, to tourists, supplementing the commercial lodge operations.

Indirect use values, or ecosystem service values, have only been studied in the Botswana basin (Turpie et al. 2006) and not in great detail. The values involved are dominated by carbon sequestration, wildlife refuge function, flood attenuation, provision of clean water and educational-scientific value. Non-use values have been studied even less, and only through tourists. The global willingness to pay or existence value for the delta is likely to be very significant as the area is widely known and respected as a conservation site.

The use of natural resources in and out of the wetland areas in Botswana has been studied and valued in detail by Turpie et al. (2006) and others (Mmopelwa (2009a, 2009b; Mbaiwa 2009; Magole 2009). The use of some 20 different natural resources was studied empirically and valued in terms of livelihoods and economic contribution. Further data on values for the rest of the basin has been provided by Mendelsohn & el Obeid (2004), Mendelsohn et al. (2006), and Saraiva (2009). Through this work, and through the environmental flows assessment (EFA) exercise, fairly reliable data are available on the value of use of natural resources by households in the basin. In particular the natural resources that can be affected by flow change, i.e., the socio-economic indicators used for the EFA model (Figure 3.2, above), have been studied in detail.

Table 6.2 derived from Saraiva (2009), Mendelsohn and el Obeid (2003; 2004), Turpie at al. (2006), and Mmopelwa (2009a, 2009b), shows the estimated proportions of household income provided by river and wetland natural resources which can be affected by flow change, i.e., those that formed the EFA indicators. An important influent on this is the amount of floodplain present, which increases from the upper basin in Angola to the delta in Botswana. Thus in Angola, households only derive some 19% of their income from river/wetland resources. There are only limited amounts of floodplain and river wetland resource use is limited mostly to fish from the river channels, and reeds and grass from the river banks. As stated, crops are important for Angolan households but these are nearly all grown in upland positions. Similarly, Angolan livestock grazing, and much thatch grass harvesting, take place in the uplands, along with all forest products harvesting. Almost no income is derived from tourism in the Angolan basin.

In Namibia there is a higher incidence of floodplains and a fair amount of tourism development which allows households in the basin to derive a higher proportion (32%) of their income from river/wetland resources. The floodplains provide some income from wetland crop production, where better water relations and humic soils enhance crop production in small scale gardens. Similarly, as stated Namibian households graze livestock for part of the time on the floodplain and derive enhanced productivity from the better water relations and specific grassland communities there. In both cases the enhancement of crop and livestock value is counted as being river/wetland based. The river and wetlands allow tourism activities which would not be there without the river. These take the form of some 30 private commercial, medium to large scale lodge investments.

In Botswana the Panhandle and Delta represent a vast floodplain area. The north, west, and south east parts of this are occupied by rural communities, while the central and north east parts are reserved for wildlife-based and nature-based tourism. Here the significant floodplain means that households in the basin derive nearly half (45%) of their income from river wetland resources. Fish, reeds, wetland grass, floodplain crops (*molapo* farming), and floodplain grazing all tend to be more significant than they are in the upper parts of the basin. As stated, the tourism industry is large, involving approximately 185 medium to large scale private commercial investments. Basin households in Botswana derive income from these through wages and salaries, but also though small scale tourism services, craft sales, and in the form of community-level royalty payments from tourism operators.

Table 6. 2: The proportions of household income in Angola Namibia and Botswana which are derived from river/wetland resources that can be influenced by flow change

Source	Country			Whole basin
	Angola	Namibia	Botswana	
River/wetland	19%	32%	45%	28%
Upland	81%	68%	55%	72%
Total	100%	100%	100%	100%

Table 6.3 shows the estimated annual livelihood and economic values for those uses of natural resources and tourism activities in the basin, which can be affected by flow change. Figure 6.1 shows the annual totals for these livelihood and economic values for each country.

Value	Livelihoods*	Direct GNI**	Total GNI***
Angola			
Fish - household	2,124,000	2,567,000	6,160,900
Reeds - household	575,500	586,400	1,407,300
Grass - household	1,357,400	1,433,400	3,440,100
Gardens - household	29,700	17,700	42,400
Grazing - household	71,800	49,500	118,700
Tourism - household	125,800	125,800	301,900
Household subtotal	**4,284,200**	**4,779,800**	**11,471,300**
Other income (tourism)	125,800	125,800	301,900
Indirect use value	0	0	1,766,000
Non-use value****	0	0	24,500
Angola total	**4,410,000**	**4,905,600**	**13,563,700**
Namibia			
Fish - household	1,455,200	1,758,700	4,221,000
Reeds - household	561,100	571,700	1,372,100
Grass - household	1,741,700	1,839,200	4,414,100
Gardens - household	314,400	187,200	449,200
Grazing - household	402,600	277,200	665,200
Tourism - household	3,700,400	3,700,400	7,400,700
Household subtotal	**8,175,400**	**8,334,400**	**18,522,300**
Other income (tourism)	3,700,400	9,549,200	19,098,400
Indirect use value	0	0	5,365,100
Non-use value****	0	0	218,700
Namibia total	**11,875,800**	**17,883,600**	**43,204,500**
Botswana			
Fish - household	252,600	305,300	732,800
Reeds - household	336,300	342,600	822,300
Grass - household	535,300	565,300	1,356,600
Gardens - household	113,500	67,600	162,200
Grazing - household	157,400	108,400	260,100
Tourism - household	21,316,300	21,316,300	42,632,700
Household subtotal	**22,711,400**	**22,705,500**	**45,966,700**
Other income (tourism)	21,316,300	55,009,100	110,018,200
Indirect use value	0	0	19,428,600
Non-use value****	0	0	1,904,000
Botswana total	**44,027,700**	**77,714,600**	**177,317,500**
Okavango River Basin			
Fish - household	3,831,800	4,631,100	11,114,700
Reeds - household	1,472,900	1,500,700	3,601,700
Grass - household	3,634,300	3,837,900	9,210,900
Gardens - household	457,600	272,400	653,700
Grazing - household	631,800	435,000	1,044,100
Tourism - household	25,142,500	25,142,500	50,335,300
Household subtotal	**35,170,900**	**35,819,600**	**75,960,400**
Other income (tourism)	25,142,600	64,684,200	129,418,300
Indirect use value	0	0	26,559,700
Non-use value****	0	0	2,147,300
Basin total	**60,313,500**	**100,503,800**	**234,085,700**

Table 6. 3: Estimated contributions of Okavango river/wetland-based natural resources to livelihoods and the national economies in Angola, Namibia, Botswana and the basin as a whole (US$, 2008)

*Household net income, contributing to livelihoods
**Direct contribution to national economy in the form of gross national income
***Total (direct and indirect) contribution to the broad economy in the form of gross national income, including the effect of the national income multiplier
****Non-use values presented here are partial ad likely seriously underestimate the real values, particularly in the lower basin

There is a striking pattern regarding the river/wetland-based natural resource use between the countries. Botswana currently generates very significantly more than Namibia, and Namibia generates significantly more than Angola. Several factors are at work here, the most important is the very high value of tourism in the model and lower basin. Another is the fact, as described in Table 6.2, people in the upper parts of the basin derive less of their income from river/wetland resources. A third factor is that households in Angola are poorer than those in the lower basin. They currently experience shortages of equipment, gear, livestock and inputs with which to earn income, a legacy of the civil war.

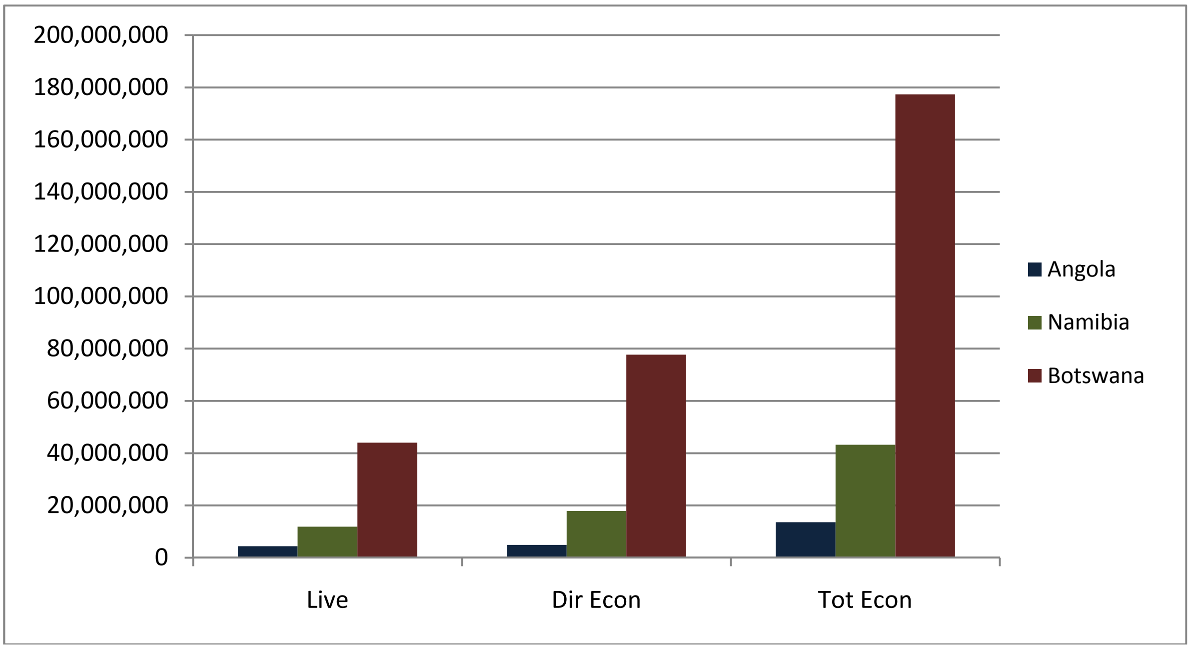

Figure 6. 1: Estimated annual contributions of Okavango river/wetland-based natural resources to household livelihoods (Live), direct gross national income (Dir Econ) and direct and indirect gross national income (Tot Econ) in Angola, Namibia, Botswana (US$, 2008)

It is also clear that the contribution of the Okavango river/wetlands to national *economies* is significant. For every dollar contributed to the livelihoods of basin residents, some 1.60 dollars is contributed directly to the national income. If the impact of the income multiplier (Lange et al. 2004; Turpie et al. 2006), indirect use values, and non-use values are taken into account, the total impact on the broader economies becomes some $4.00. The economic contribution of the flow-based natural resources in the Okavango river/wetland system to the Angolan, Namibian, and Botswana national economies can be estimated. In terms of direct GNI the river/wetland system contributes 0.01%, 0.23% and 0.45% of the Angolan, Namibian and Botswana economies respectively. In terms of total (direct and indirect) GNI the river/wetland system contributes 0.02%, 0.56% and 1.03% of the Angolan, Namibian and Botswana economies respectively. It can be seen that the contribution in Angola is small, while it is moderate in Namibia and quite significant in Botswana. Comparing these figures with those of Table 6.2 above, it can be seen that the river/wetland system is very important as a contributor to the livelihoods of people living along the system, while it is relatively unimportant in the national economic context.

Box 2: How do the different flow related river/wetland natural resource uses contribute to livelihoods and the national economies?

Where households along the river make direct use of the river wetland resources, for example when they use fish, floodplain plants and floodplain grazing, they invest directly in the activity and derive net incomes (in kind and/or in cash), which contribute directly to their household welfare. These are small scale activities, for which the major input tends to be household labour. Linkages between these activities and the broader economies are generally restricted to their purchase of equipment or inputs (backward linkages to fish net manufactures and suppliers for example), or to any product processing that takes place (forward linkages to grain milling enterprises for example). These linkages and the consequent impacts on the national economies are relatively small.

The other significant flow-based river/wetland natural resource contributor to the livelihoods of households in the basin is tourism. Here, local households derive significant amounts of cash income from employment and rentals. Tourism involves large scale lodge investments, which are relatively complex, capital intensive, and owned as a rule by formal sector businesses. The livelihoods they provide to local households are complemented by further income in the form of salaries and wages to other employees, profits accruing to owners, payments to lenders of capital, and taxes accruing to governments. Tourism enterprises also have lateral linkages in that tourists spend money in the country, travelling to and from the lodges, and backward linkages in that lodges buy most of their capital and operating inputs from other sectors in the broader economy. The consequent impacts of tourism activities on the national economies are relatively large, compared with those from household-based enterprises.

Figures 6.2 to 6.4 show the proportions contributed annually by different river/wetland-based natural resource uses to the household livelihoods in each country. The Angolan figure shows the importance of harvest of river channel resources such as fish, reeds and grass. In Botswana other floodplain natural resource uses, such as gardens and grazing, become a little more important, and wage income from tourism becomes very significant. In Botswana the very large impact on households from the wetland-based tourism industry dominates, although households do derive greater amounts of their income from harvest of river/wetland resources.

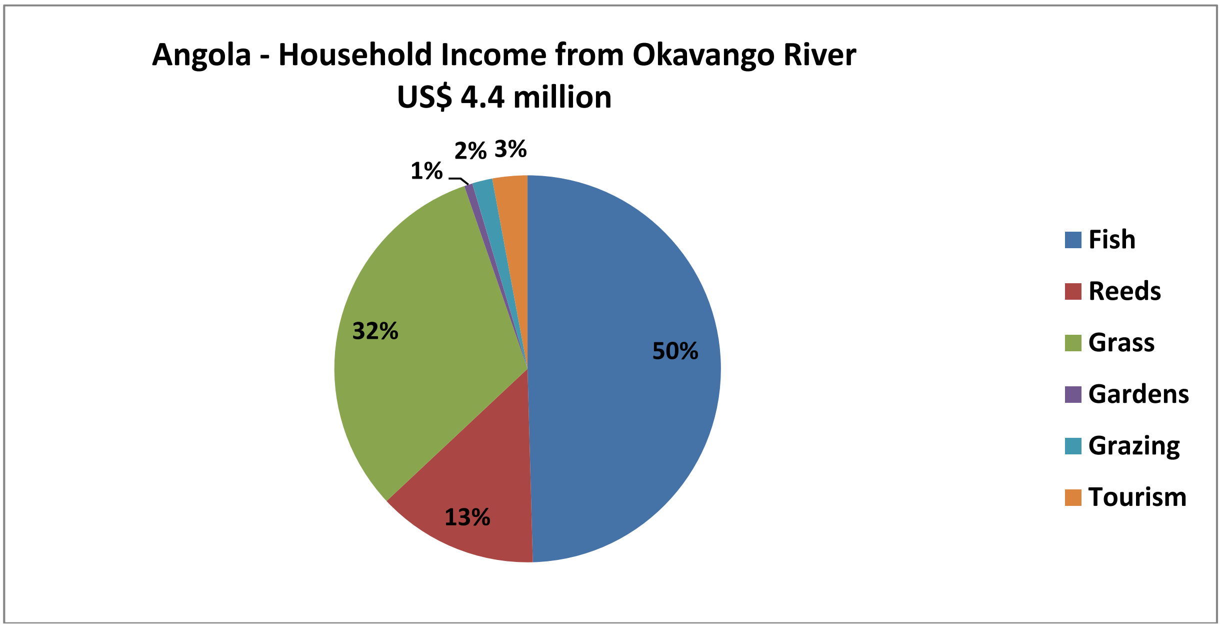

Figure 6. 2: Estimated livelihood value of Okavango river/wetland based natural resource use in Angola in 2008

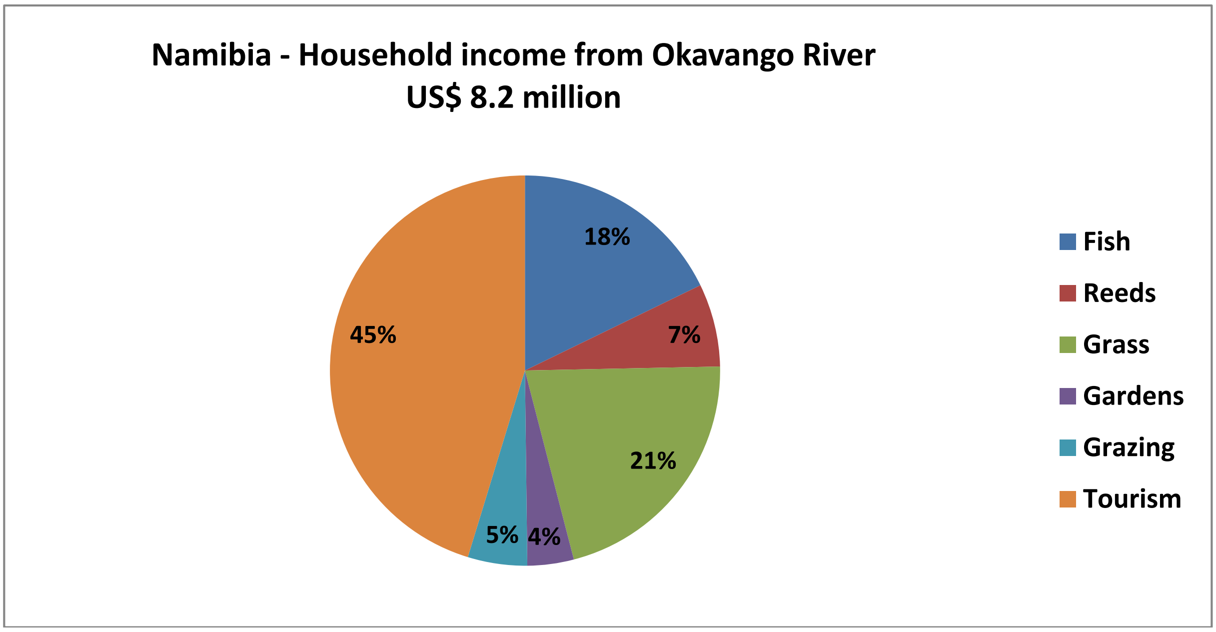

Figure 6. 3: Estimated livelihood value of Okavango river/wetland based natural resource use in Namibia in 2008

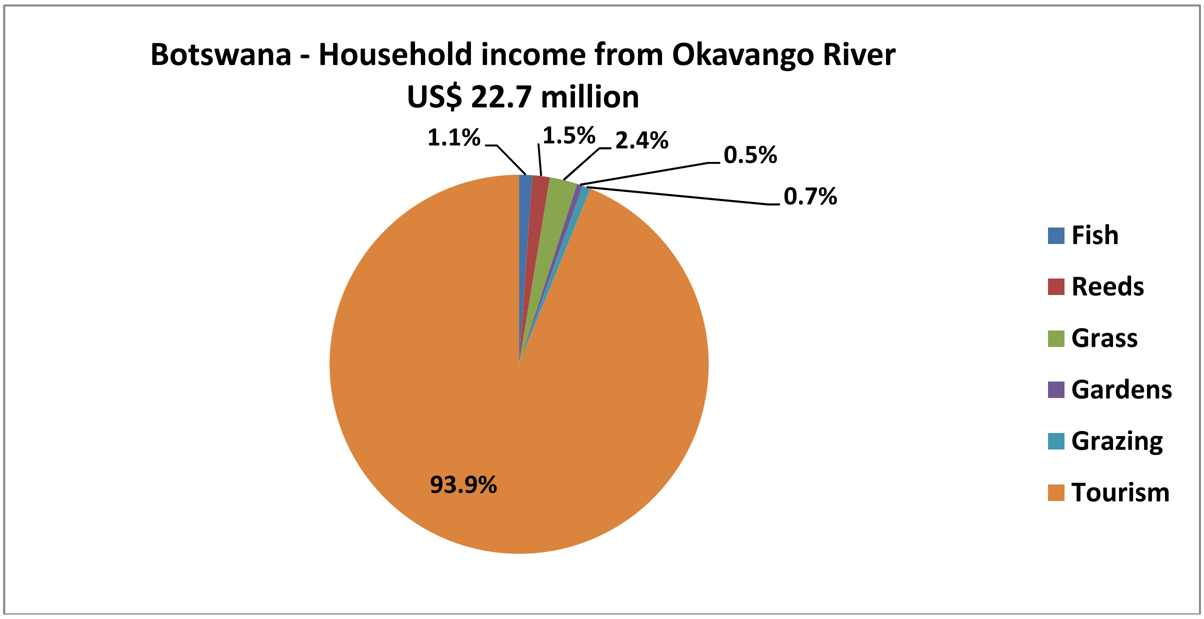

Figure 6. 4: Estimated livelihood value of Okavango river/wetland based natural resource use in Botswana in 2008

Variation on between different IUAs in terms of river/wetland based annual livelihood values is illustrated in Figures 6.5 to 6.10. In Figures 6.5 and 6.6, the difference between the Cubango and Cuito arms of the basin in Angola is evident. On the Cubango, at Mucundi, in IUA 2, the river is a single channel with no floodplain, and products of only three river-based indicators are harvested. At Cuito in IUA 6, there is a floodplain and additional income from floodplain gardens and floodplain grazing is obtained. In Figures 6.7 and 6.8, the markedly different livelihood characteristics of IUA 8 and IUA 9 in Namibia are evident. In IUA 8 the full range of river and floodplain resources are harvested, while tourism is moderately significant. In the Popa area, in IUA 9, there are no floodplain resources, but the proximity of river-based tourism attractions, including the Bwabwata National Park, means that households derive a significant amount of their river-based livelihoods from tourism. In Botswana, differences in livelihoods between IUA 10 and IUA 11 are evident in Figures 6.9 and 6.10. Here, again, tourism is the biggest river/wetland-based household income contributor, but more so in IUA 11.

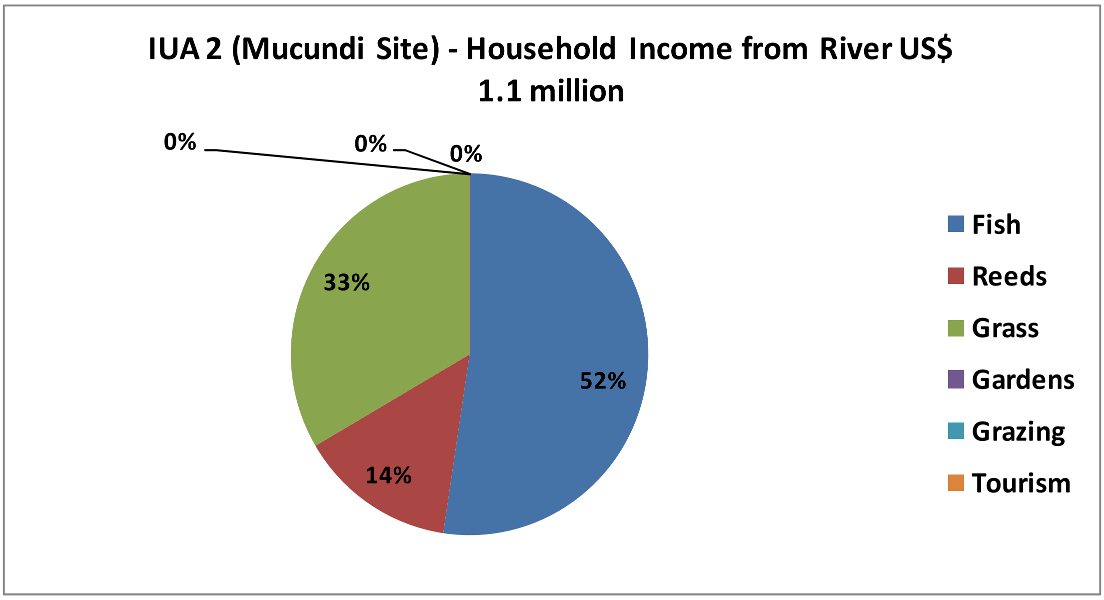

Figure 6. 5: Estimated livelihood value of river/wetland based natural resource use in IUA 2 in Angola, 2008

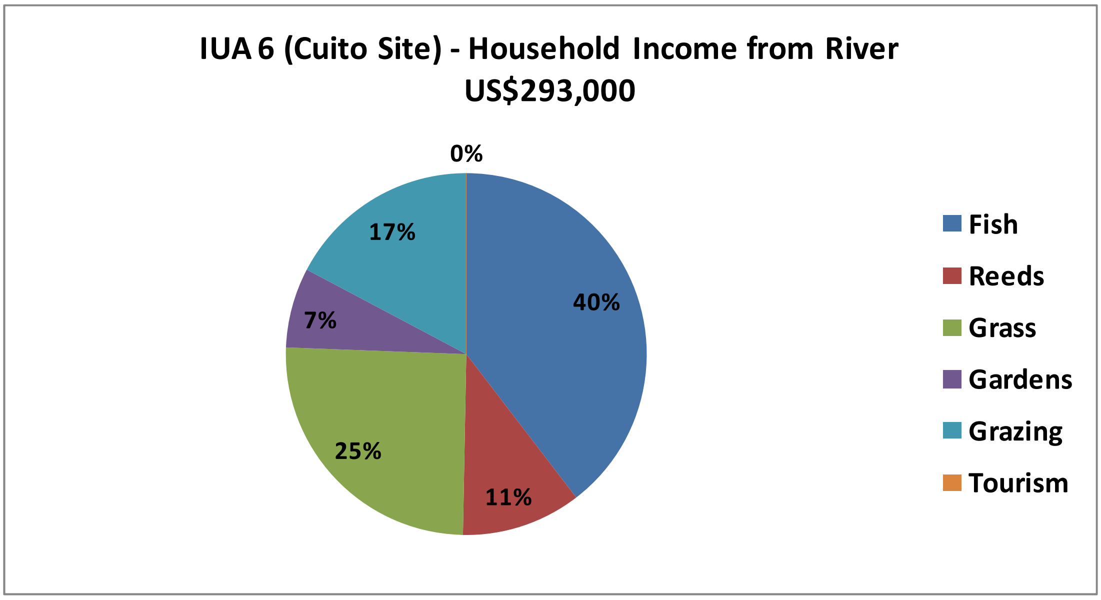

Figure 6. 6: Estimated livelihood value of river/wetland based natural resource use in IUA 6 in Angola, 2008

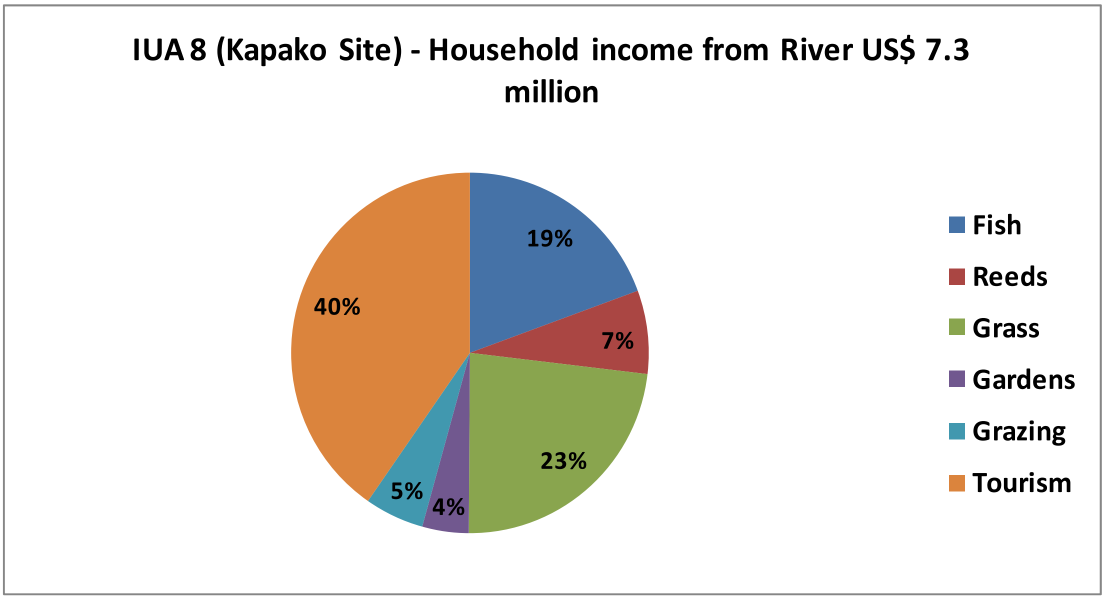

Figure 6. 7: Estimated livelihood value of river/wetland based natural resource use in IUA 8 in Namibia, 2008

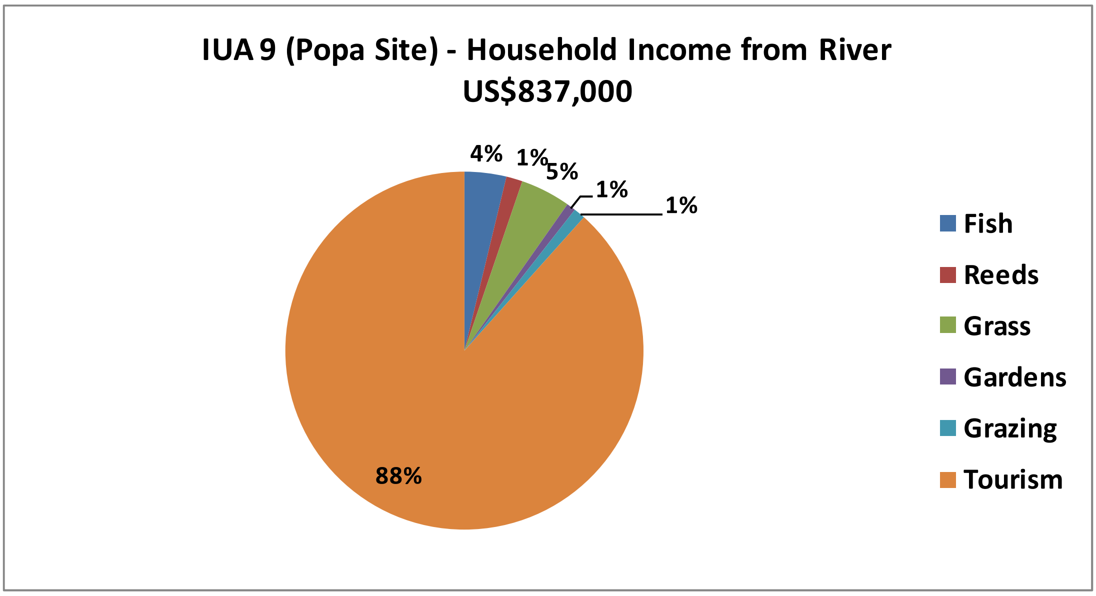

Figure 6. 8: Estimated livelihood value of river/wetland based natural resource use in IUA 9 in Namibia, 2008

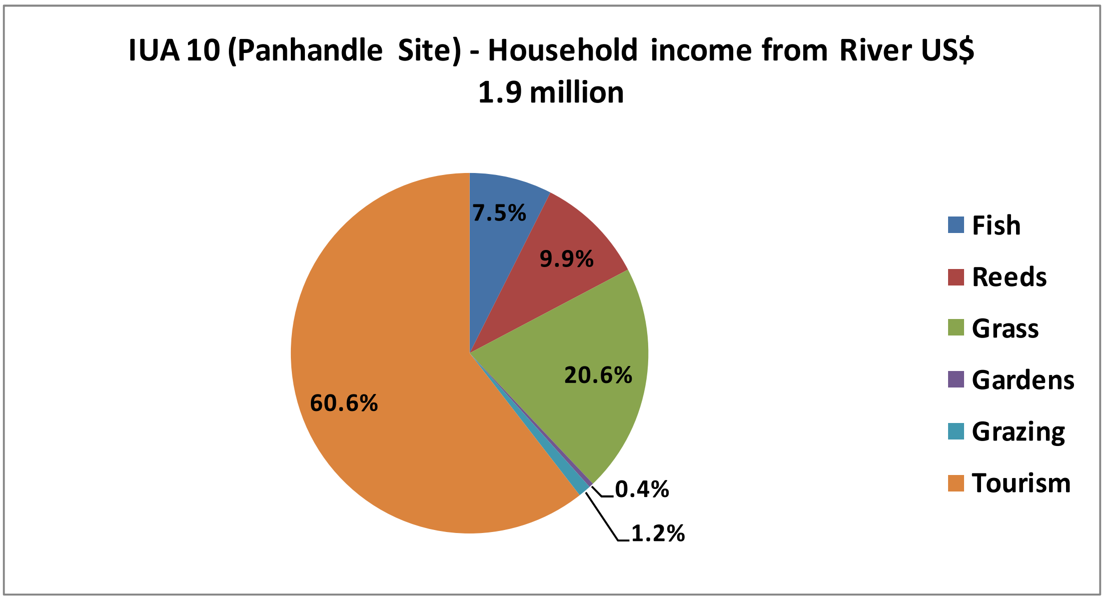

Figure 6. 9: Estimated livelihood value of river/wetland based natural resource use in IUA 10 in Botswana, 2008

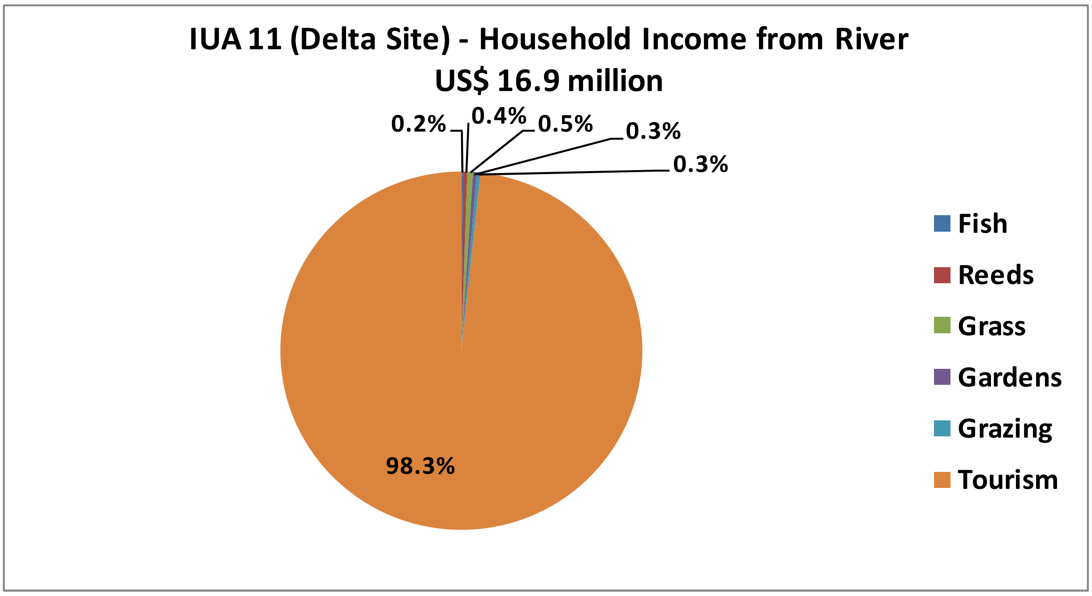

Figure 6. 10: Estimated livelihood value of river/wetland based natural resource use in IUA 11 in Botswana, 2008

Figures 6.11 to 6.13 show how the use of Okavango river basin, flow-related, river/wetland-based natural resources in Angola, Namibia and Botswana impacts annually on the broader economies of those countries.

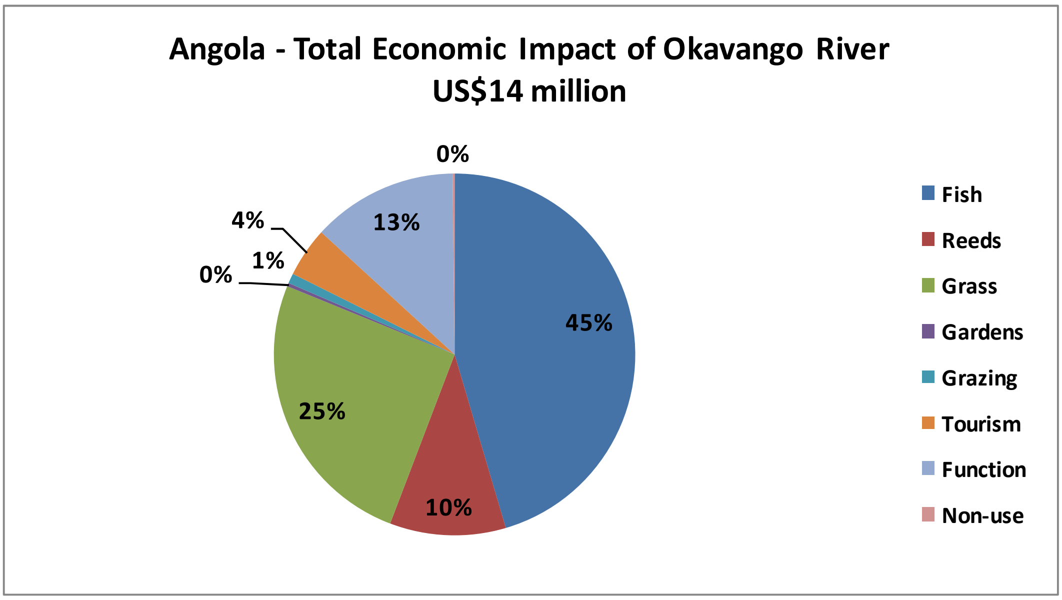

Figure 6. 11: Estimated total direct and indirect impact of Okavango river/wetland based natural resource use in the Angolan basin on the Angolan economy in 2008

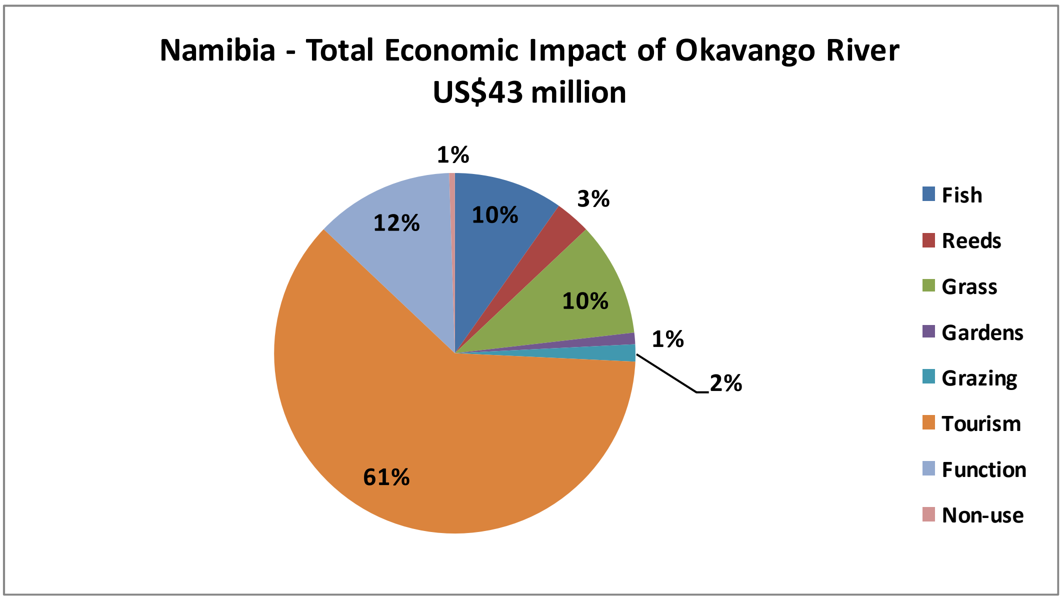

Figure 6. 12: Estimated total direct and indirect impact of Okavango river/wetland based natural resource use in the Namibian basin on the Namibian economy in 2008

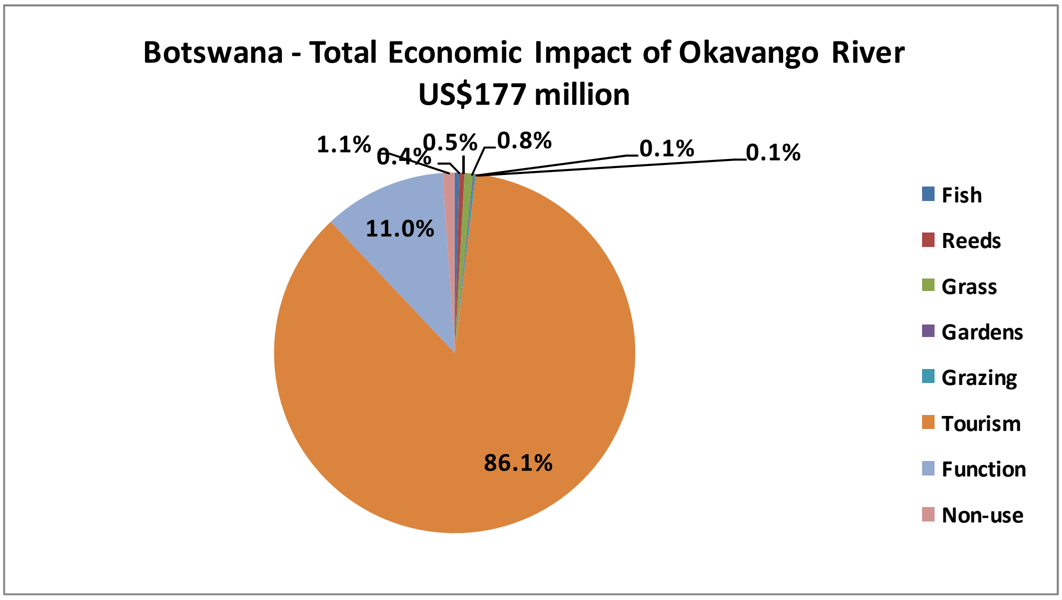

Figure 6. 13: Estimated total direct and indirect impact of Okavango river/wetland based natural resource use in the Botswana basin on the Botswana economy in 2008

The Okavango river basin is relatively underdeveloped compared with most other river basins in southern Africa. The natural systems are reasonably intact, leaving a number of options open for future economic development. The nature of the developments will be critical to ensuring that they contribute maximally to the development of the basin countries while alleviating poverty, particularly in the basin itself. To do this the developments need to make the most of whatever comparative advantages the basin has for development.

Studies show that small-scale household uses of natural resources are generally economically efficient (Turpie et al. 2001, 2006). They have appropriate technology, labour intensiveness, capital extensiveness, minimisation of risk, and lack of dependence on markets which makes them suitable for contributing livelihoods and earning income in remote parts, such as the Okavango basin. Our empirically-based private and economic budget/cost-benefit enterprise models show that most small scale natural resources are feasible, with positive contributions to the national economies, which gives them local comparative advantage.

The very high private and economic values associated with tourism in the basin, most notably in Botswana but also in Namibia, suggest that tourism developments making use of the natural river/wetland environment are comparatively advantageous. Indeed, the empirical private and economic budget/cost-benefit models of tourism developments used in the analysis above and derived from Turpie et al. (2006) show significant economic viability. As medium to large scale commercial investments, they are less dependent on proximity to markets and offer a unique product not attainable anywhere else.

Other options for development in the basin include hydropower generation, irrigated agriculture, and water extraction for urban use. The socio-economic work did not examine the economics of these as they are not considered to be affected by flow change. Their value is the subject of the macro-economic assessment background report. The only developments so far are in commercial irrigation, in Namibia, where some 2,600 hectares of land is irrigated to produce food and high value cash crops.

Nevertheless Schuh et al. (2006) showed commercial irrigation to be only viable if a significant proportion of the crops planted are of high value. Liebenberg (2009) provided detailed investment budgets for the examples of irrigated high value crop (essential oils) and food crop (maize and wheat) production in the Namibian basin. This provided an opportunity for irrigated crop viability analysis using the same private and economic, budget/cost-benefit, enterprise models used for tourism. Table 6.4, below shows some comparative results for tourism and commercial irrigation models.

The results show tourism lodge development to be both financially viable and very efficient economically. The high value crop irrigation system, as formulated, was not financially profitable, but it was economically efficient, indicating that it might be economically appropriate to subsidise it. To achieve financial viability, subsidies would need to amount to some half the initial capital costs, or half the annual turnover. Food crop production was found to be both financially and economically unsound. The analysis demonstrates that there is likely to be a clear comparative advantage in the basin for tourism over commercial irrigated crops, mainly due to the remoteness of these investments from markets.

1. Non consumptive tourism (18 bed lodge)								
Initial Capital	8,956,111							
Annual Turnover	9,986,371							
	Normal prices							
Financial Return	**IRR**	**NPV @ 8%**						
10 year	**8.11%**	**71,758**						
20 year	**11.96%**	**4,120,158**						
40 year	**12.87%**	**6,887,395**						
Direct Economic Return	**IRR**	**NPV @ 8%**						
10 year	**41.02%**	**16,522,767**						
20 year	**41.39%**	**25,310,663**						
40 year	**41.41%**	**31,617,949**						
		NPV@4%						
40 year		**60,414,018**						
2. Irrigated essential oil production (100 ha)								
Initial Capital	24,871,606							
Annual Turnover	7,824,274							
	Normal prices		**Fuel cost * 0.5**		**Capital costs * 0.5**		**Product prices * 1.5**	
Financial Return	**IRR**	**NPV @ 8%**	**IRR**	**NPV @ 8%**	**IRR**	**NPV @ 8%**	**IRR**	**NPV @ 8%**
10 year	-1.46%	-14,210,965	3.77%	-4,987,582	**10.44%**	**2,072,423**	**10.90%**	**4,629,459**
20 year	1.57%	-14,915,674	6.73%	-2,366,904	**13.13%**	**6,974,352**	**13.32%**	**13,482,025**

2. Irrigated essential oil production (100 ha) (Continued)								
40 year	3.01%	-15,316,809	7.78%	-533,404	**13.75%**	**10,334,833**	**13.88%**	**19,558,255**
Direct Economic Return	**IRR**	**NPV @ 8%**	**IRR**	**NPV @ 8%**	**IRR**	**NPV @ 8%**	**IRR**	**NPV @ 8%**
10 year	**9.78%**	**2,299,531**	**16.65%**	**8,677,676**	**27.08%**	**13,543,073**	**22.94%**	**20,017,507**

20 year	**11.62%**	**7,249,468**	**17.96%**	**15,365,463**	**27.76%**	**21,272,823**	**24.00%**	**33,707,351**
40 year	**12.22%**	**11,077,120**	**18.25%**	**20,328,508**	**27.85%**	**26,899,625**	**24.15%**	**43,458,404**
		NPV@4%						
40 year		**36,793,517**						
3. Irrigated grain production (100 ha)								
Initial Capital	13,678,562							
Annual Turnover	4,860,100							
	Normal prices		**Fuel cost * 0.5**		**Capital costs * 0.5**		**Product prices * 1.5**	
Financial Return	**IRR**	**NPV @ 8%**	**IRR**	**NPV @ 8%**	**IRR**	**NPV @ 8%**	**IRR**	**NPV @ 8%**
10 year	Negative	-19,101,397	Negative	-11,995,982	Negative	-9,462,045	-2.21%	-7,526,360
20 year	Negative	-25,233,761	Negative	-15,263,864	Negative	-12,071,828	0.97%	-7,786,998
40 year	Negative	-29,066,525	Negative	-17,236,099	Negative	-13,678,889	3.07%	-7,640,248
Direct Economic Return	**IRR**	**NPV @ 8%**	**IRR**	**NPV @ 8%**	**IRR**	**NPV @ 8%**	**IRR**	**NPV @ 8%**
10 year	-3.38%	-7,128,112	3.77%	-2,092,295	6.64%	-483,725	**13.80%**	**3,903,470**
20 year	-0.64%	-7,993,253	6.67%	-1,016,483	**9.69%**	**950,193**	**15.95%**	**8,481,383**
40 year	1.69%	-8,186,099	**8.01%**	**7,762**	**10.75%**	**2,118,766**	**16.45%**	**11,977,522**
		NPV@4%						
40 year		-5,001,794						

Table 6. 4: Financial and economic analysis of commercial tourism and irrigated agriculture in the Okavango river basin, Namibia (shading indicates viability) (% or N$, 2008)

7. Socio-economic scenario analysis

The scenarios which were tested on the environmental flows assessment (EFA) model were four; the 'present day' plus three alternative water use development scenarios. The present day scenario included all existing water resource developments, notably:

Some 2,600 ha of irrigation in Namibia
The urban water demands of Menongue and Cuito Cuanavale (Angola), Rundu (Namibia), and Maun (Botswana)

A low growth scenario was based on the continuation of historical growth in water demands in the three countries. Growth rates in Angola reflected recent acceleration associated with resettlement in de-mined areas. Increased water consumption was mainly due to growth in urban and rural domestic, livestock and irrigation water demands. The largest water demands were represented by:

Some 3,100 ha of irrigation in Namibia
Some 18,000 ha of irrigation along the Cuebe River in Angola
One storage based and three run-of-river hydropower stations in Angola

A medium growth or “business-as-usual” scenario included:

Some 8,400 ha of irrigation in Namibia
Development of a first phase of the Eastern National Carrier (17 Mm3/a) for water supply from the Kavango to Grootfontein and Windhoek,
Some 198,000 ha of irrigation at various locations in Angola
One storage based and four run-of-river hydropower stations in Angola

A high growth scenario included:

Some 15,000 ha of irrigation in Namibia
Some 338,000 ha of irrigation at various locations in Angola
Completion of all planned hydropower stations in Angola, i.e. one storage based and nine run-of-river hydropower stations in Angola ,
Completion of a second phase of the Eastern National Carrier (total capacity 100Mm3/a),
Development of a scaled down version of the Southern Okavango Integrated Water Development Scheme (SOIWD) for urban and industrial water supply from the Delta to Maun.
At these levels of demand, it was necessary to introduce a hypothetical dam in the upper basin (Cuchi River) with a capacity of some 500 million m3 to provide for shortfalls in irrigation water supply and inter-basin transfers.

7.1 Short term scenario analysis

Many of the impacts of flow change on the river and the river ecosystem as described in detail in the EFA scenario reports (King et al. 2009a, 2009b), translate into impacts on the livelihoods and economic welfare of the basin's people and economies. In the EFA the biophysical responses modeled were linked to changes in abundance and availability of natural resource products used in the basin. These abundance responses were applied to enterprise models which measure private net incomes (livelihoods) and economic national income (economic contribution) and which were developed for the natural resource uses. Thus, flow changes predicted for the water use scenarios were translated into responses predicting their effects on livelihoods and economies.

Figure 7.1 and 7.2 show the aggregate short term responses to flow change due to the water use scenarios, in terms of annual livelihoods and the annual direct economic contribution to national income.

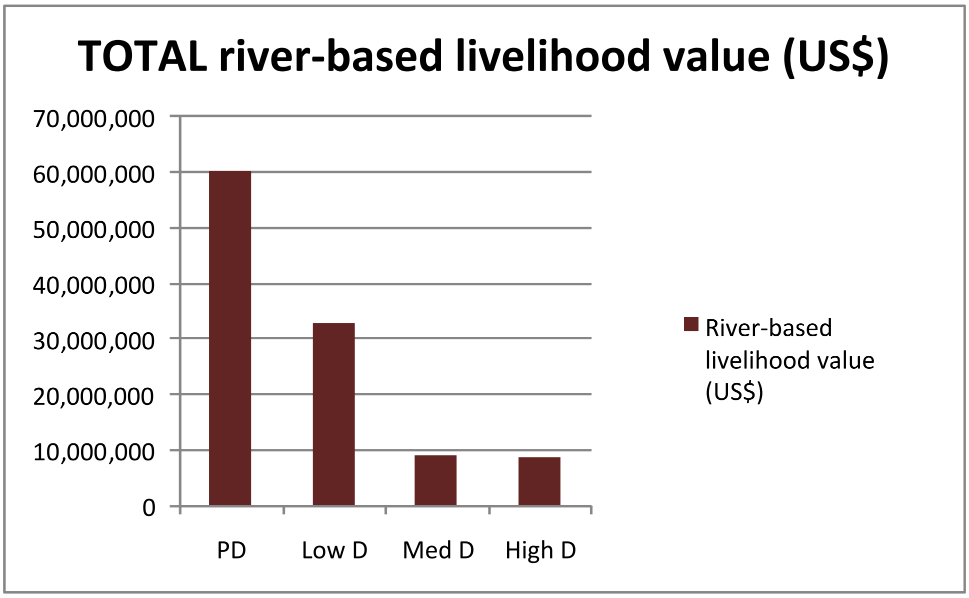

Figure 7. 1: The short term implications for livelihoods in the whole Okavango river basin with present day (PD), low development (Low Dev), medium development (Med Dev) and high development (High Dev) water use scenarios (US$, 2008)

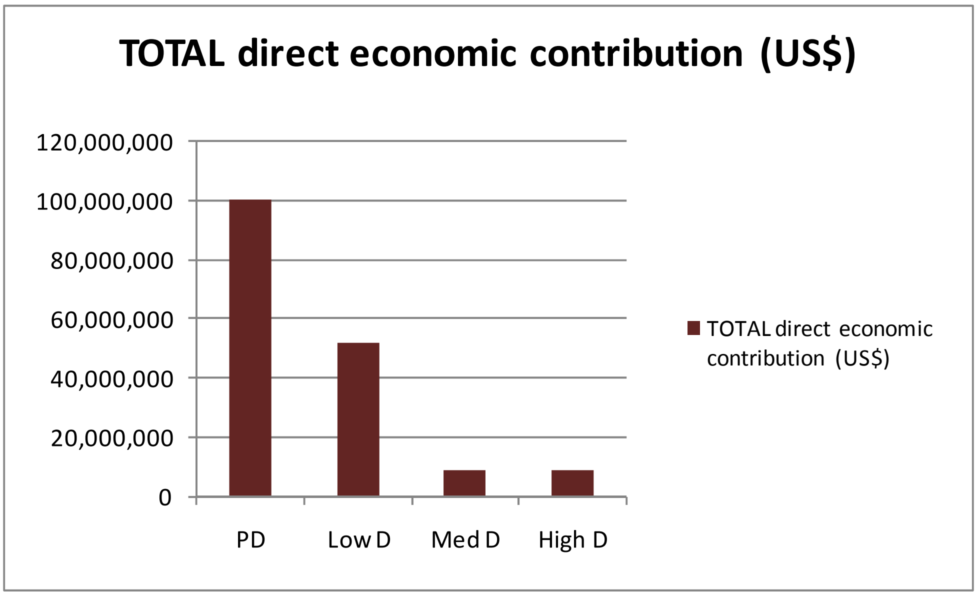

Figure 7. 2: The short term implications for direct economic income in the whole Okavango river basin with present day (PD), low development (Low Dev), medium development (Med Dev) and high development (High Dev) water use scenarios (US$ 2008)

Both livelihoods and national income are predicted to decline in the scenarios, with the medium and high water use options showing a devastating decline. This is primarily as a result of decline predicted for tourism. A very high value for tourism was measured in the lower parts of the basin and the scenario impacts on this value were found to be very high during preliminary response analysis. Because of the heavy significance of the finding, a supplementary survey was carried out among Okavango delta tourism operators to determine their perceptions regarding the likely impacts of flow and flood change on their operations (Mbaiwa & Mmopelwa 2009). Figure 7.3 shows some results from this survey. It shows a complex short term response, where turnover would drop by some 15% in the face of changes in the flood regime which would make the delta wetter or drier to different degrees. The response curve reflecting these values was combined with the responses to two other tourism influents, channel low-flow levels, and wildlife abundance. Then responses were applied to the tourism enterprise model to measure changes in occupancy levels and consequent effects on net incomes (livelihoods) and value added (economic contribution). The results confirmed the initial findings. Relatively small, sustained reductions in tourism demand would severely reduce these values.

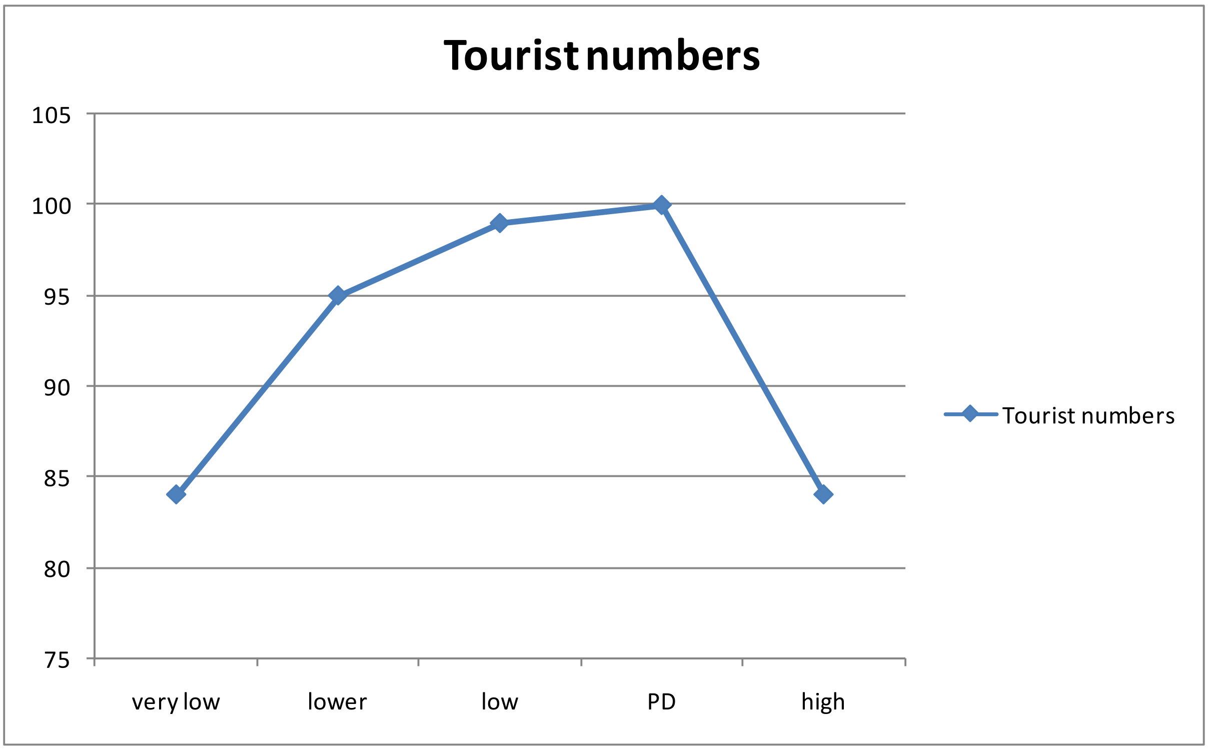

Figure 7. 3: Expected short term changes in tourist numbers predicted by tourism operators in Botswana (% of present day (PD), which equal 100%), in the face of four different changes to average flooding levels (2008)

Figures 7.4 to 7.6 below show the expected short term impacts on annual livelihoods separately for each of Angola, Namibia, and Botswana. The results show differences in that livelihoods are affected more dramatically in Botswana than in Angola and Botswana at the distal end of the basin. The impact that the scenarios have on tourism is again the main reason.

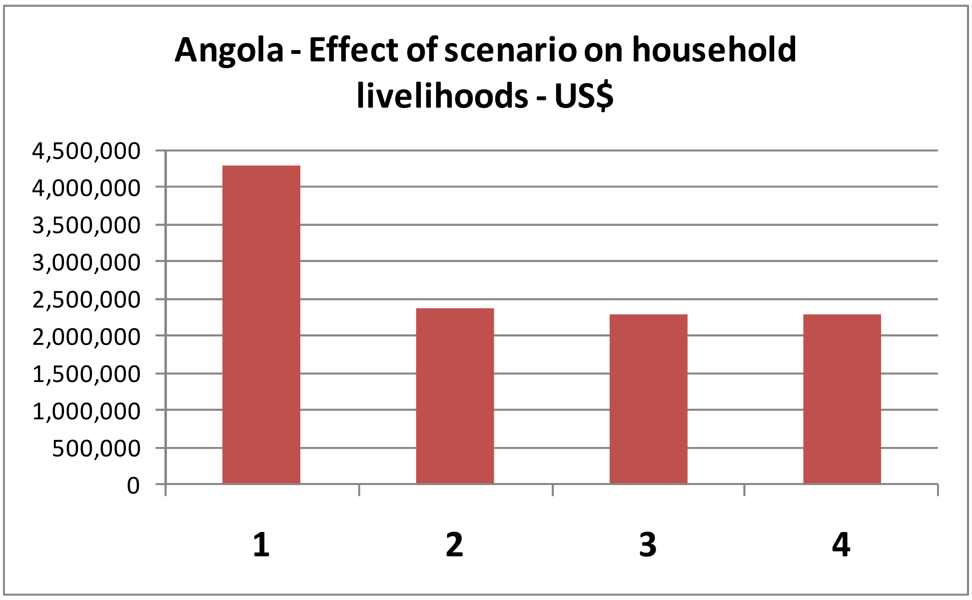

Figure 7. 4: The short term implications for livelihoods in the Angolan part of the Okavango river basin with present day (1), low development (2), medium development (3) and high development (4) water use scenarios (US$, 2008)

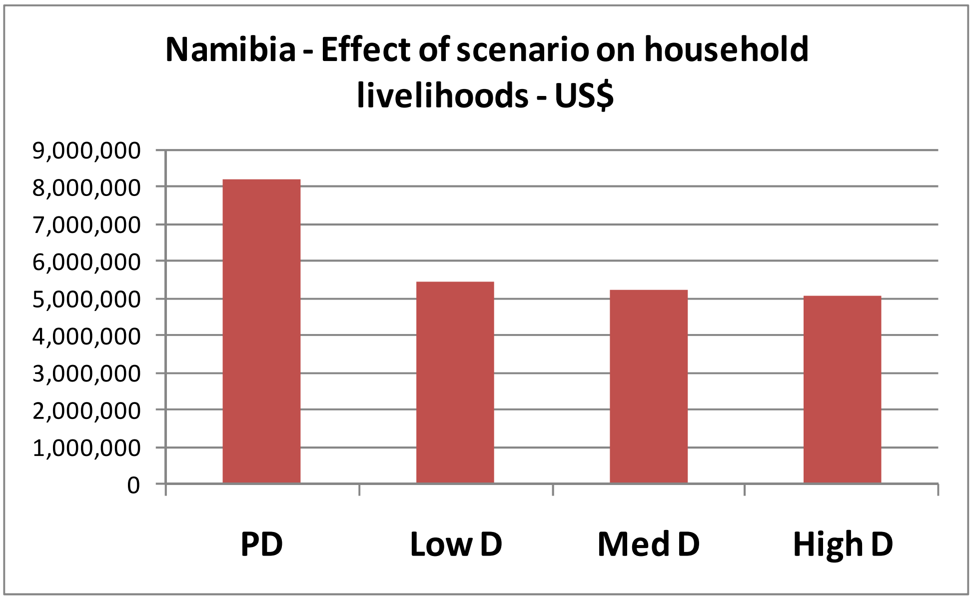

Figure 7. 5: The short term implications for livelihoods in the Namibian part of the Okavango river basin with present day (PD), low development (Low Dev), medium development (Med Dev) and high development (High Dev) water use scenarios (US$, 2008)

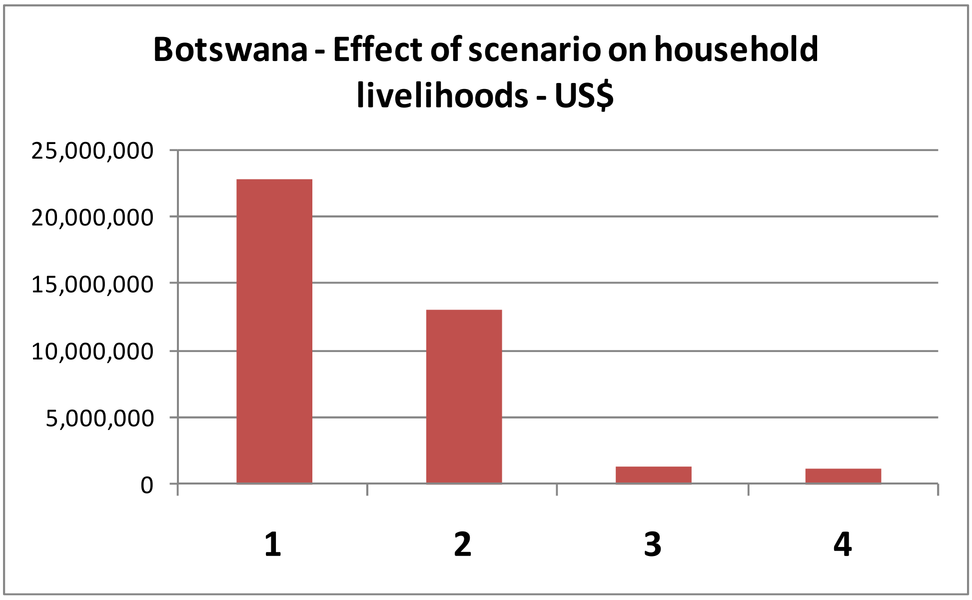

Figure 7. 6: The short term implications for livelihoods in the Botswana part of the Okavango river basin with present day (1), low development (2), medium development (3) and high development (4) water use scenarios (US$, 2008)

By its nature the EFA socio-economic model determined only short term impacts on livelihoods, and economies, and did not consider medium and long term long adaptation in the basin tourism sector, or changes such as those expected from human population growth and tourism demand growth. These were incorporated into the next stage of the analysis, where each impact in the model was modeled over a 40 year period, incorporating predicted changes in these factors. Forty year net present values were estimated to provide a more realistic measure of scenario impact. The results of this are shown below.

7.2 Long term scenario analysis

This section examines how future change is likely to impact on the people of the basin and their socio-economic wellbeing. From a transboundary perspective, relative gains and losses between the peoples of the three basin countries, are important. Also important are equity issues; how might the distribution of income change, and who gains and who loses from this?

A good idea of likely future pressures and possible consequences to the local population can be got from the results of the EFA, where the impact of three different water use scenarios on the natural resource base and the ensuing impact of this change on the socio-economic environment of the basin were examined. The EFA specifically examined those uses of basin natural resources that might be affected by flow change. The EFA model, described above, examined in detail the immediate impact of flow change on the livelihoods of river basin populations and their direct contributions to local and national economies. It did not include longer term impacts resulting from adaptation to change, as well as from population growth, or from the effects of climate change. The analysis was carried further to analyse how the livelihoods and economic contributions would change in the long term.

For each scenario, using the immediate impacts as a base, 40 year discounted streams of expected future direct income streams were generated. These included expected future population growth, tourism demand growth and expected long term adaptations where relevant. Thus, growth in natural resources use due to population increase was assumed to be 1.5% per annum in Botswana and Namibia, and 2.5% in Angola. Tourism demand was anticipated to grow at 5% per annum on average in all scenarios. Where tourism was found to collapse as a result of drying of the lower system, its output was assumed to settle at levels (25%, 10%, and 5% of present day values) depending on the scenario. These levels were deemed more or less consistent with what one might expect in the surrounding savannas, or in comparable savanna areas, e.g., Hwange National Park. Further, carrying capacity limits to growth for certain activities were assumed, +75% of starting output in the case of tourism, and +100% of starting output in the case of fishing). The adaptation assumptions were subjective, while assumptions on growth in tourism demand and populations were more analytical.

Direct contribution to the national income is a comprehensive measure that includes the basin household net income, as well as the income to other basin investors, and stakeholders. Household net income has been used as a useful indicator, but the direct economic contribution provides a better measure the true impact on socio-economic welfare attributable to activities in the basin. It has thus been used to value change as discussed below.

Tables 7.1 to 7.4 show how the 40 year net present values of future streams of directly generated income, for the river/wetland based natural resources uses in the Angolan, Namibian, and Botswana parts of the basin, and in the basin as a whole, change with the EFA scenarios for water use.

In Angola the water development scenarios will reduce the direct income derived from river/wetland natural resources use by some 40%. The effect is the same for all rural household natural resource use as this makes up nearly all of the income generated. Figure 7.7 shows how the effect would not differ very much between the three water use scenarios. Among the specific natural resources used, the value of fish would be the most affected with some 60% of the income lost with each of the scenarios, which again did not differ much in their impact. Figure 7.8 shows this. The other main river wetland resources used, reeds and floodplain grass, would lose some 30% of their value with the three water use scenarios.

Scenario:	Present day	Low Development	Med Development	High Development
Net present value @ 4%				
Tourism sector	5,866,500	5,866,500	5,866,500	5,866,500
Rural household sector	141,051,200	78,159,800	74,992,500	76,790,800
TOTAL resource use	146,917,700	84,026,300	80,859,000	82,657,300
Fish use	75,322,900	30,267,600	27,270,600	27,128,300
Floodplain reeds use	17,229,100	12,073,000	12,057,800	12,105,700
Floodplain grass use	40,893,300	28,213,300	28,058,200	29,950,800
Floodplain gardens	457,800	457,800	457,800	457,800
Floodplain grazing	1,281,700	1,281,700	1,281,700	1,281,700
Tourism wages	5,866,500	5,866,500	5,866,500	5,866,500
Losses from present day				
Tourism sector		0	0	0
Rural household sector		62,891,300	66,058,600	64,260,400
TOTAL resource use		62,891,300	66,058,600	64,260,400
Fish use		45,055,300	48,052,300	48,194,600
Floodplain reeds use		5,156,000	5,171,300	5,123,300
Floodplain grass use		12,680,000	12,835,100	10,942,500
Floodplain gardens		0	0	0
Floodplain grazing		0	0	0
Tourism wages		0	0	0

Table 7. 1: Effect of low medium and high water use scenarios on the 40 year net present values (NPVs) for direct economic income attributable to river/floodplain natural resources use in the Angolan part of the Okavango river basin (US$, 2008)

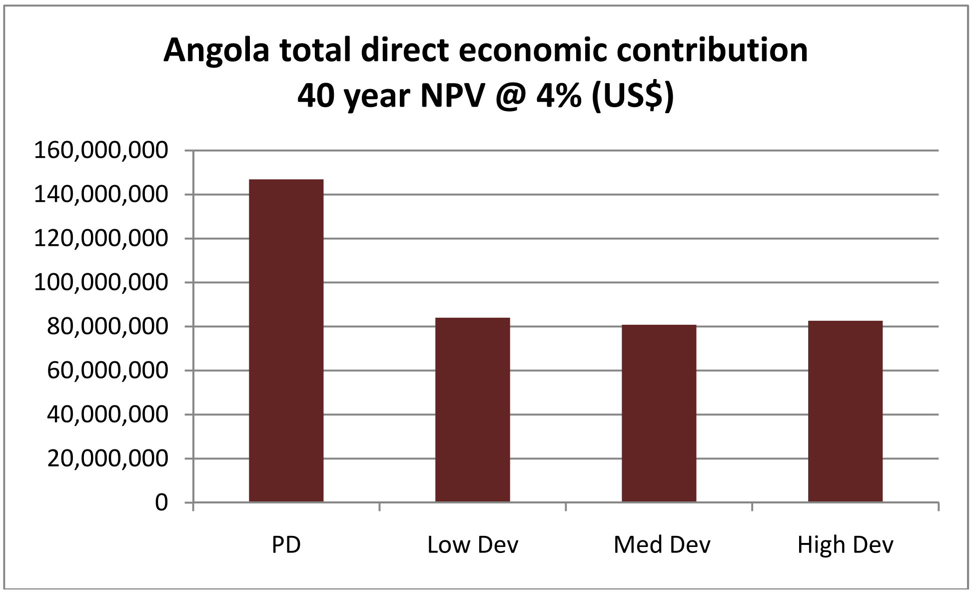

Figure 7. 7: Effect on direct economic contribution of all river/wetland natural resource use in the Angolan Okavango river basin with present day (PD), low development (Low Dev), medium development (Med Dev) and high development (High Dev) water use scenarios

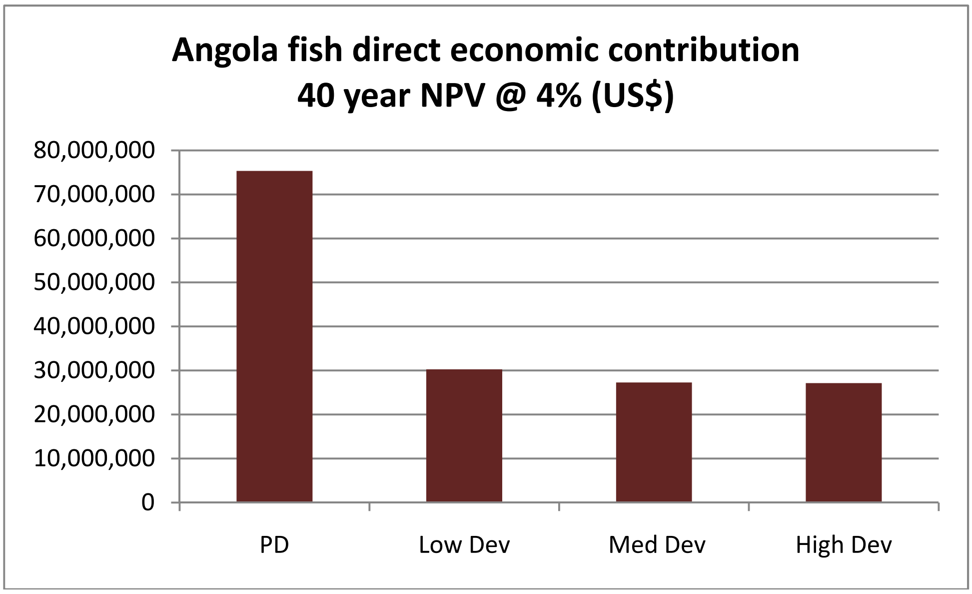

Figure 7. 8: Effect on direct economic contribution of all household use of fish in the Angolan Okavango river basin with present day (PD), low development (Low Dev), medium development (Med Dev) and high development (High Dev) water use scenarios

Table 7.2 shows the effects of the same scenarios on the same river/wetland resource use values for Namibia. Here the impact of the water use changes on the total income from river/wetland natural resource uses would be greater than in Angola at around 60%. As the present day values for Namibia are much larger than those for Angola, the losses are even greater than would be apparent. Figures 7.9 to 7.12 show various scenario effects for Namibia from Table 7.2. Figure 7.9 indicates that the low development scenario has a slightly lesser impact than the others. The loss to the value of all household river/wetland natural resource use is lesser at around 40%. The very large impact in this part of the basin is that on tourism sector income. The change in flow resulting from the scenarios would reduce the income generated by river/wetland tourism by some 75%. Generally the low water use scenario has a lower impact than the others, with the medium water use only very slightly better than high water use in terms of impact. An interesting finding is that household incomes from all of reeds, floodplain grass, floodplain crops, and floodplain grazing are likely to rise by some 10% with the three water use scenarios. This is due to the fact that certain resources, most notably river bank, and floodplain, vegetation zones, would increase as a result of water use developments. The low water use scenario would generate the highest increase in each case. Overall the amounts involved with these wetland resources are relatively small, and the overwhelming impact will be with the reduced tourism income.

Scenario:	Present day	Low Development	Med Development	High Development
Net present value @ 4%				
Tourism sector	286,183,100	79,677,200	50,273,800	49,576,500
Rural household sector	224,152,200	148,255,900	133,053,600	129,614,200
TOTAL resource use	510,335,300	227,933,200	183,327,400	179,190,700
Fish use	42,983,600	38,501,600	36,319,100	34,586,900
Floodplain reeds use	13,972,500	15,727,700	15,370,100	15,408,900
Floodplain grass use	44,950,300	50,590,400	49,446,400	48,832,500
Floodplain gardens	4,574,000	5,013,300	4,997,200	4,905,800
Floodplain grazing	6,774,200	7,547,400	7,439,400	6,668,900
Tourism wages	110,897,600	30,875,400	19,481,400	19,211,200
Losses from present day				
Tourism sector		206,505,900	235,909,300	236,606,600
Rural household sector		75,896,300	91,098,600	94,538,000
TOTAL resource use		282,402,100	327,007,900	331,144,600
Fish use		4,482,000	6,664,500	8,396,600
Floodplain reeds use		(1,755,200)	(1,397,600)	(1,436,400)
Floodplain grass use		(5,640,200)	(4,496,100)	(3,882,200)
Floodplain gardens		(439,300)	(423,100)	(331,800)
Floodplain grazing		(773,200)	(665,200)	105,300
Tourism wages		80,022,200	91,416,200	91,686,400

Table 7. 2: Effect of low medium and high water use scenarios on the 40 year net present values (NPVs) of direct economic income attributable to river/floodplain natural resources use in the Namibian part of the Okavango river basin (US$, 2008)

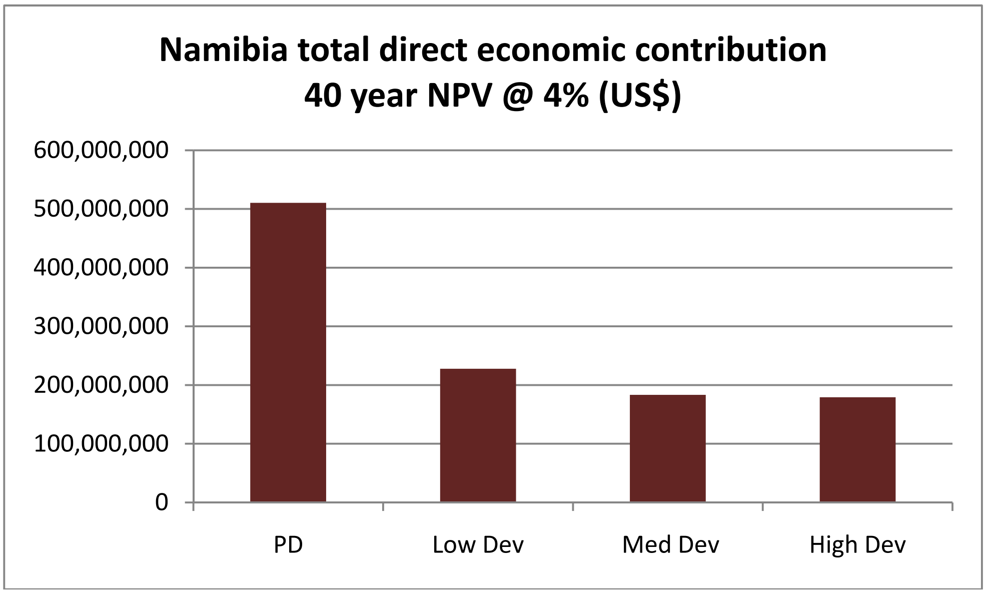

Figure 7. 9: Effect on direct economic contribution of all river/wetland natural resources use in the Namibian Okavango river basin with present day (PD), low development (Low Dev), medium development (Med Dev) and high development (High Dev) water use scenarios

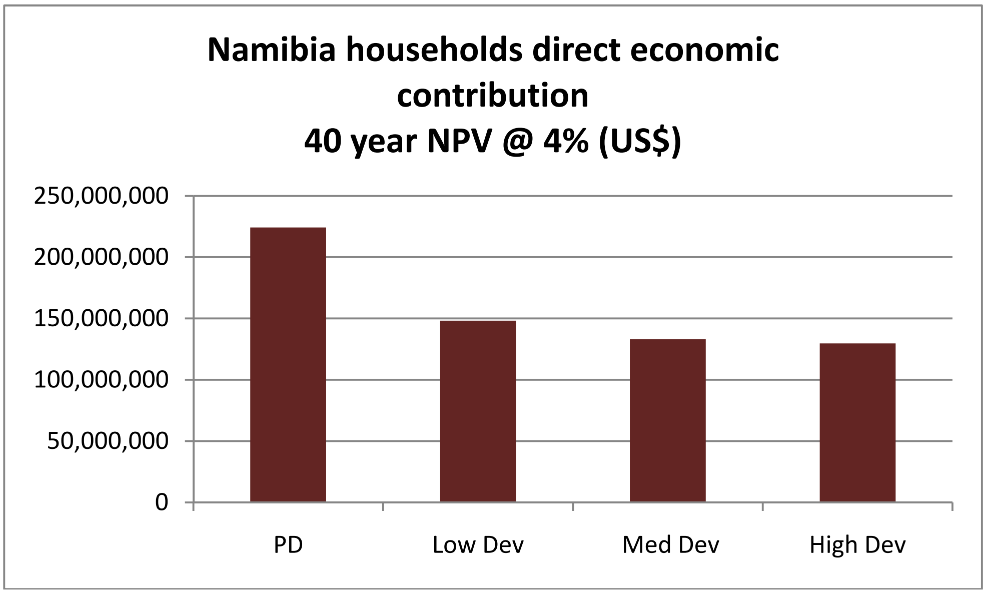

Figure 7. 10: Effect on direct economic contribution of all household use of river/wetland natural resources in the Namibian Okavango river basin with present day (PD), low development (Low Dev), medium development (Med Dev) and high development (High Dev) water use

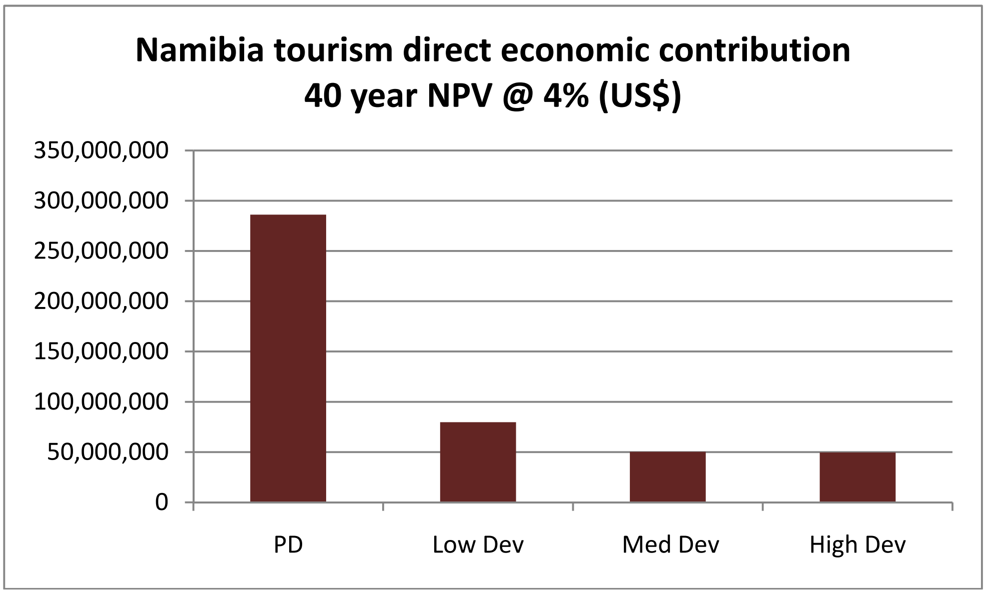

Figure 7. 11: Effect on direct economic contribution of river/wetland based tourism in the Namibian Okavango river basin with present day (PD), low development (Low Dev), medium development (Med Dev) and high development (High Dev) water use scenarios

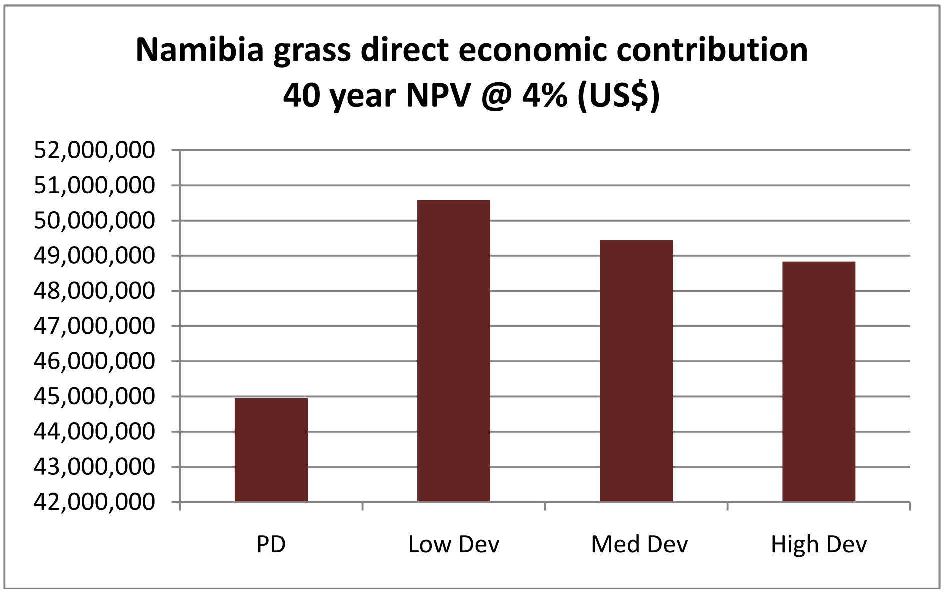

Figure 7. 12: Effect on direct economic contribution of household use of floodplain grass in the Namibian Okavango river basin with present day (PD), low development (Low Dev), medium development (Med Dev) and high development (High Dev) water use scenarios

Table 7.3 shows the effects of the water use scenarios on the same river/wetland resource use values, this time for Botswana. Here the impact on income of the medium and high water use scenarios is devastating. It is relatively moderate for the low use scenario. The overwhelmingly dominant income earner in the Botswana basin is tourism. Income from tourism is reduced by some 40% with low water use and by some 90% with both medium and high use. Figures 7.13 to 7.15 show how this effect is similar for all income generated, whether by households, or tourism sector activities, or both. In the case of Botswana the present day income from the river/wetland system is much higher than that for Namibia and very much higher than that for Angola, so that the losses there would be enormous by comparison.

The results on the analysis for the specific household natural resource uses in Botswana are interesting. Different impact patterns emerge relative to the scenarios for the different resources. Thus household income from fish shows an accelerating decline (Figure 7.16), that from floodplain grass would be highest with the medium water use scenario (Figure 7.17), that from reeds would be similar, that from floodplain crops would remain relatively stable, and that from floodplain grazing would collapse except with the high water use scenario, when it would rise (Figure 7.18). Once again, the impact of these patterns is quite small since the income involved is relatively small.

Scenario:	**Present day**	**Low Development**	**Med Development**	**High Development**
Net present value @ 4%				
Tourism sector	1,697,546,600	1,003,678,900	142,964,400	150,898,600
Rural household sector	692,364,700	420,525,700	108,017,900	89,311,000
TOTAL resource use	2,389,911,300	1,424,204,700	250,982,300	240,209,600
Fish use	7,598,700	6,679,500	5,475,900	2,822,200
Floodplain reeds use	8,520,900	8,584,600	8,794,100	8,733,500
Floodplain grass use	14,058,000	14,153,100	14,448,700	14,149,500
Floodplain gardens	1,681,000	1,891,200	1,823,200	2,035,600
Floodplain grazing	2,696,700	285,900	143,800	3,096,100
Tourism wages	657,809,300	388,931,500	77,332,400	58,474,100
Losses from present day				
Tourism sector		693,867,700	1,554,582,200	1,546,648,100
Rural household sector		271,838,900	584,346,700	603,053,700
TOTAL resource use		965,706,600	2,138,929,000	2,149,701,700
Fish use		919,200	2,122,800	4,776,500
Floodplain reeds use		(63,700)	(273,100)	(212,600)
Floodplain grass use		(95,000)	(390,600)	(91,500)
Floodplain gardens		(210,100)	(142,200)	(354,600)
Floodplain grazing		2,410,800	2,552,900	(399,400)
Tourism wages		268,877,800	580,476,900	599,335,200

Table 7. 3: Effect of low medium and high water use scenarios on the 40 year net present values (NPVs) of direct economic income attributable to river/floodplain natural resources use in the Botswana part of the Okavango river basin (US$, 2008)

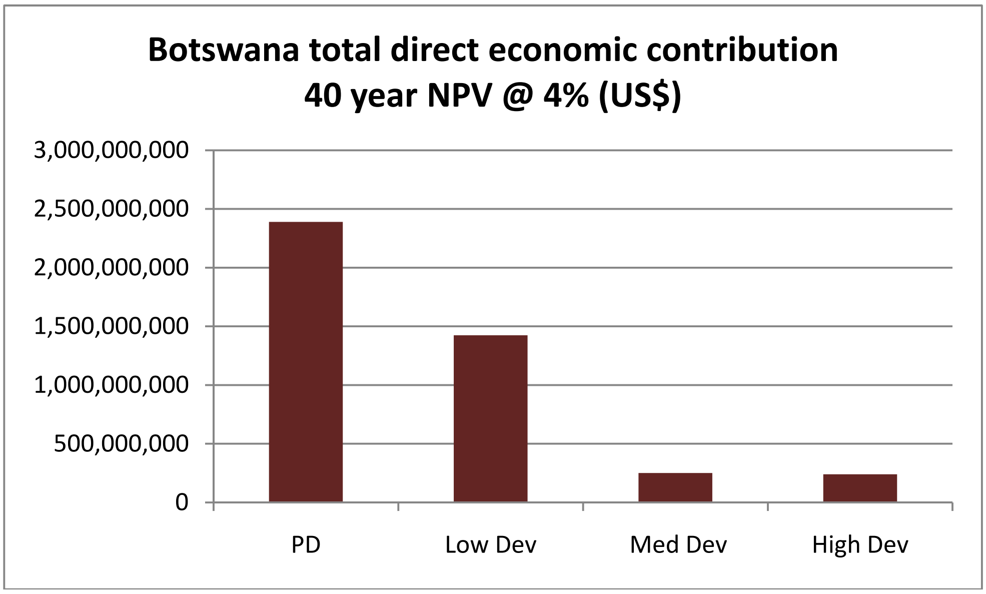

Figure 7. 13: Effect on direct economic contribution of all river/wetland natural resource use in the Botswana Okavango river basin with present day (PD), low development (Low Dev), medium development (Med Dev) and high development (High Dev) water use scenarios

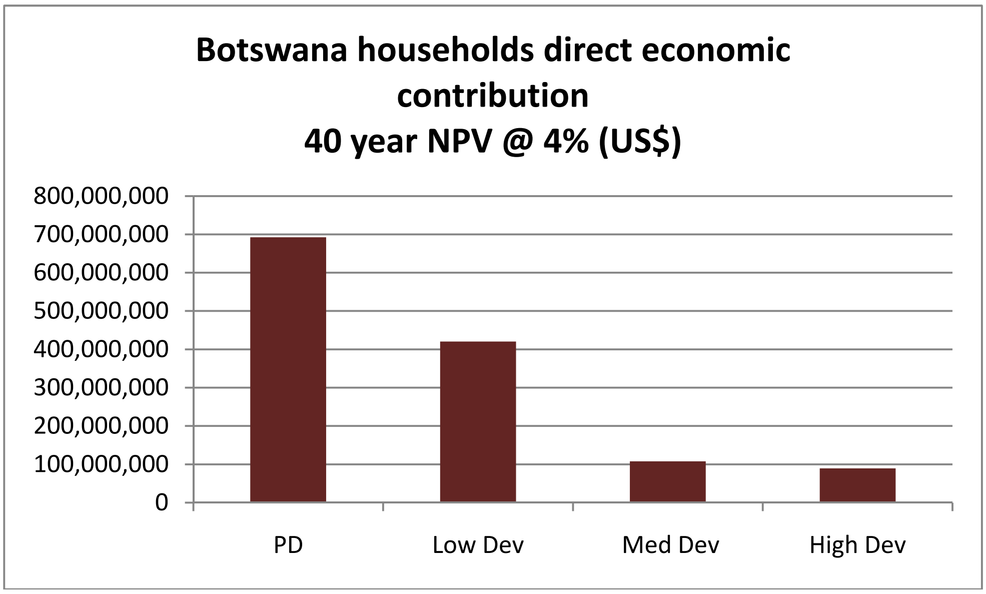

Figure 7. 14: Effect on direct economic contribution of all household river/wetland natural resources use in the Botswana Okavango river basin with present day (PD), low development (Low Dev), medium development (Med Dev) and high development (High Dev) water use sc

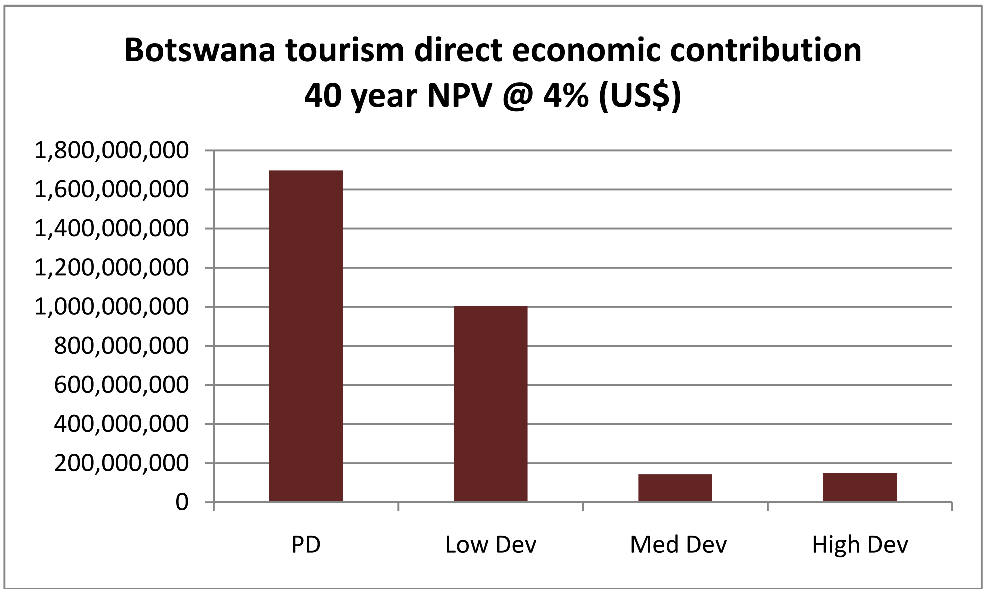

Figure 7. 15: Effect on direct economic contribution of use of river/wetland natural resources for tourism in the Botswana Okavango river basin with present day (PD), low development (Low Dev), medium development (Med Dev) and high development (High Dev) water use s

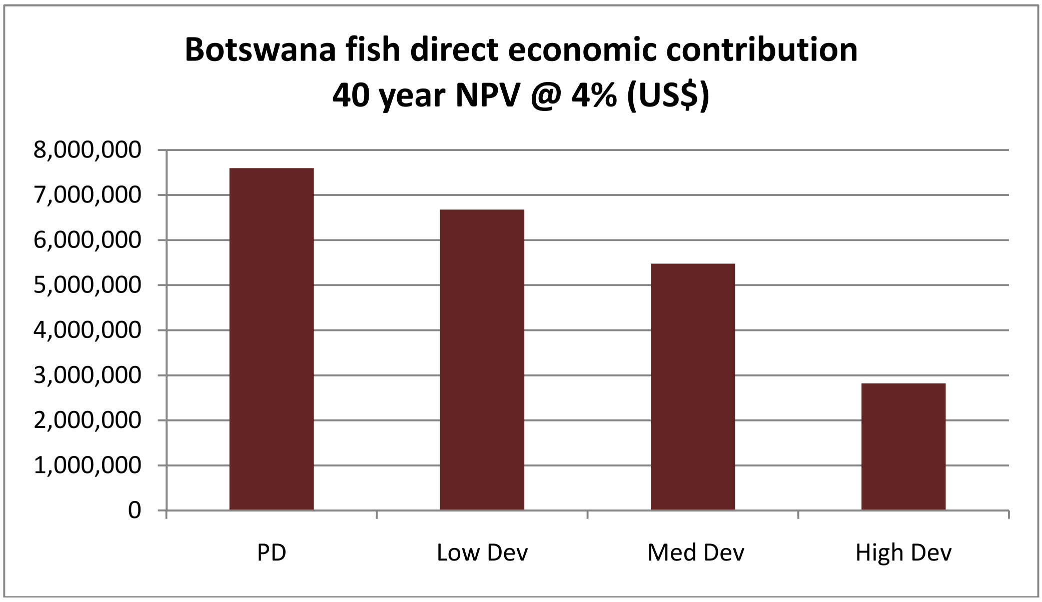

Figure 7. 16: Effect on direct economic contribution of household use of fish in the Botswana Okavango river basin with present day (PD), low development (Low Dev), medium development (Med Dev) and high development (High Dev) water use scenarios

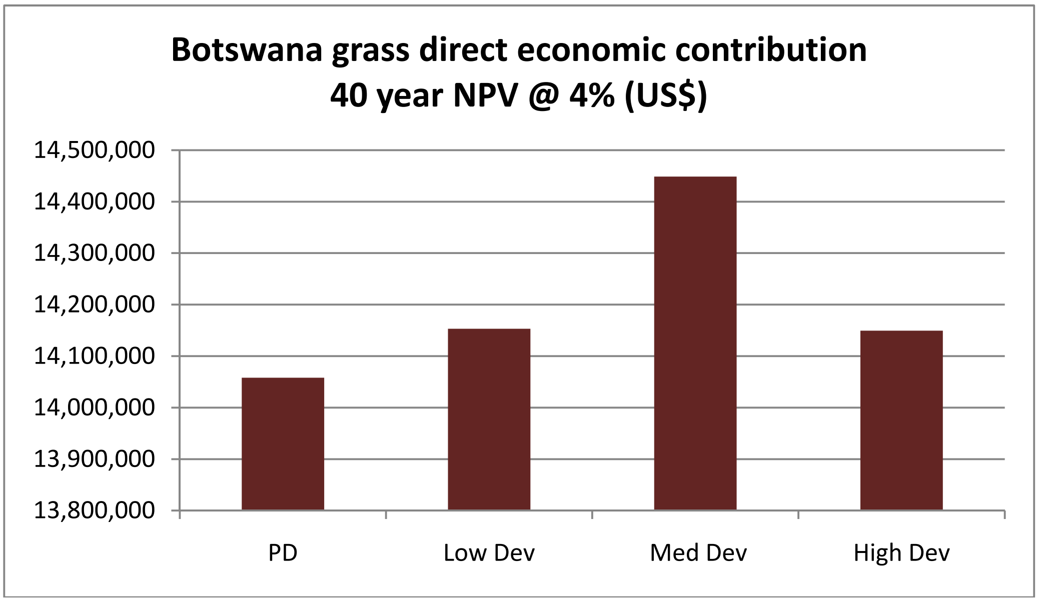

Figure 7. 17: Effect on direct economic contribution of household use of floodplain grass in the Botswana Okavango river basin with present day (PD), low development (Low Dev), medium development (Med Dev) and high development (High Dev) water use scenarios

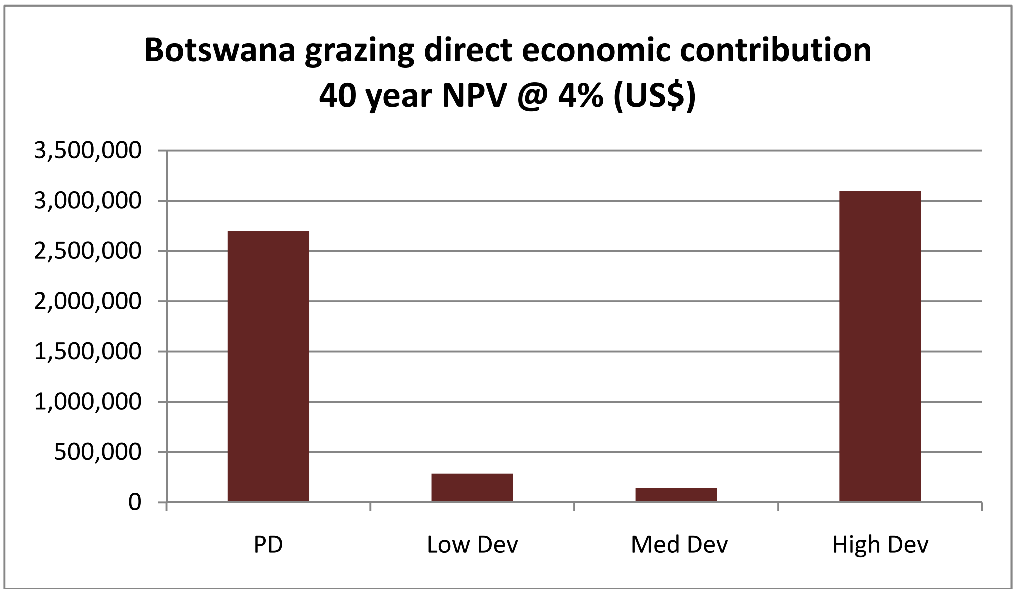

Figure 7. 18: Effect on direct economic contribution of household floodplain grazing in the Botswana Okavango river basin with present day (PD), low development (Low Dev), medium development (Med Dev) and high development (High Dev) water use scenarios

Table 7.4 combines the data for all the three countries, summarizing the results for the basin as a whole. Here the overwhelming dominance of the scenario effects on the income earned in Botswana comes through. Thus, as shown in Figure 7.19, the impact of the low water use scenario on all river/wetland natural resource uses in the Okavango basin is moderate, and those for the medium and high water use scenarios are devastating.

Scenario:	Present day	Low Development	Med Development	High Development
Net present value @ 4%				
Tourism sector	1,989,596,200	1,089,222,700	199,104,700	206,341,600
Rural household sector	1,057,568,000	646,941,500	316,064,000	295,715,900
TOTAL resource use	3,047,164,200	1,736,164,100	515,168,700	502,057,500
Fish use	125,905,100	75,448,600	69,065,500	64,537,400
Floodplain reeds use	39,722,500	36,385,300	36,221,900	36,248,100
Floodplain grass use	99,901,600	92,956,800	91,953,300	92,932,800
Floodplain gardens	6,712,800	7,362,300	7,278,200	7,399,200
Floodplain grazing	10,752,600	9,115,000	8,864,900	11,046,700
Tourism wages	774,573,400	425,673,400	102,680,300	83,551,800
Losses from present day				
Tourism sector		900,373,500	1,740,491,500	1,783,254,600
Rural household sector		410,626,600	741,504,000	761,852,100
TOTAL resource use		1,311,000,100	2,531,995,500	2,545,106,700
Fish use		50,456,500	56,839,600	61,367,700
Floodplain reeds use		3,337,100	3,500,600	3,474,400
Floodplain grass use		6,944,800	7,948,300	6,968,800
Floodplain gardens		(649,400)	(565,300)	(686,400)
Floodplain grazing		1,637,600	1,887,700	(294,100)
Tourism wages		348,900,000	671,893,100	691,021,600

Table 7. 4: Effect of low medium and high water use scenarios on the 40 year net present values (NPVs) of direct economic income attributable to river/floodplain natural resources use in the Okavango river basin as a whole (US$, 2008)

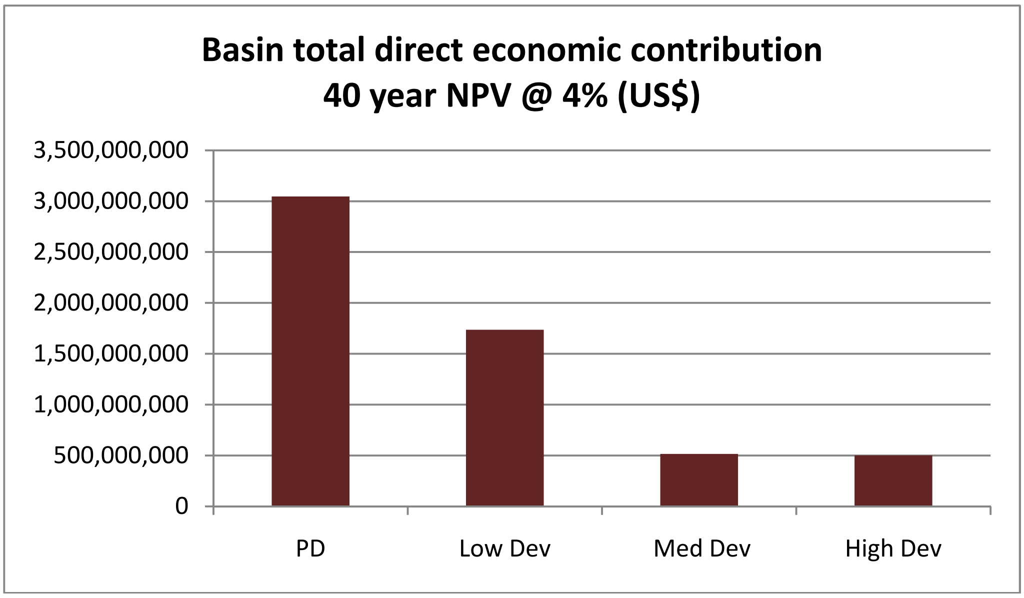

Figure 7. 19: Effect on direct economic contribution of all river/wetland natural resource use in the Okavango river basin as a whole with present day (PD), low development (Low Dev), medium development (Med Dev) and high development (High Dev) water use scenarios

The evidence above suggests that water use developments along the lines of the low, medium, and high use scenarios, will significantly reduce the income that people in the basin and its associated economies can derive from natural river/wetland resources. For the medium and high water use scenarios, the aggregate losses in Angola may be lowest, at some US$65 million. In Namibia these aggregate losses may be some five times greater at some US$330 million. In Botswana the medium and high water scenarios may cause aggregate losses some 30 times greater than those in Angola, at some US$2.1 billion.

Given the aggregate losses above, and the proportions of total household income derived from river/wetland resources in each country, (19%, 32% and 45% for Angola, Namibia and Botswana, respectively), it is possible to calculate the amount of its annual income an average rural household in each country might lose. Table 7.5 shows this.

Scenario:	Present day	Low Development	Med Development	High Development
Angolan basin	0%	8%	9%	9%
Namibian basin	0%	11%	13%	13%
Botswana basin	0%	18%	38%	39%
Whole basin	0%	11%	20%	20%

Table 7. 5: Proportion of income lost by the average rural household in Angolan, Namibian, and Botswana parts of the Okavango river basin and the whole basin, with low, medium, and high water use scenarios

With the medium and high water use scenarios the average rural household in the Angolan part of the basin would lose some 9% of its livelihood. Rural households in the Namibian part of the basin might lose something like 13% of their livelihood on average, and those in the Botswana part of the basin might lose 39% of theirs.

The aggregate losses in income sustained by Botswana and, to a lesser extent, Namibia will thus impact on basin populations which are already poor, relative to the broader populations of their countries. These populations are already targets for development, and the losses could thus be of enhanced concern. In addition to this, it can be seen in Table 7.4 that, the aggregate losses are likely to be greater for the tourism industry than for the rural household sector. Thus the impact on the main income earners in this industry, investors, owners of capital, government, and employees, including wage earners from the rural populations themselves, might be even greater than for the rural population as a whole.

The emerging picture is that the people in the Angolan basin currently derive relatively little income from the river/wetland system, while those in the countries downstream, and most notably Botswana, derive considerably more from it. By far the majority of this income is based on the natural status of the system, with tourism, based on the natural wetland system and its wildlife, making up the bulk of this. Botswana has invested in this natural system through land allocation and protection, and relies on it for the bulk of its basin economy.

Angola supplies the water for the river basin system and needs to develop the system for its own benefit. Namibia also wishes to increase the income it derives from the system. The water use scenarios would develop the river in Angola and Namibia in ways that should enhance their own income from the river, but the way this is done needs very careful analysis and planning.

Very important will be to ensure that developments are economically efficient, while minimising the damage to existing income generation. Also important will be ensuring that water developments do not increase poverty. While these developments are aimed at increasing the amount of income coming from the river system, particularly in the upper basin, they may not necessarily reduce poverty. The poverty within the basin, which tends to be worse than that in the broader basin country societies, may be exacerbated if water developments and their backward and forward economic linkages serve only the formal sectors outside the basin. In this case benefits will be skewed towards higher income segments of society. In the basin the poorest elements of resident societies have tended to rely on direct use of natural resources, including the river/wetland based ones for a significant part of their livelihoods. Further, these river/wetland-based natural resources have tended to provide them with a safety net in times of adversity. Without careful planning of development, losses in livelihoods for poor basin residents could significantly increase their vulnerability.

8 Conclusion

The Okavango river basin is thus far relatively unaffected by development. The inhabitants of the basin tend to be poorer than their representative populations, and mostly rural. Progress in human development in the basin is being negated in Namibia and Botswana as a result of the HIV/AIDS pandemic. Basin populations rely significantly on natural resources for their livelihoods.

River/wetland-based natural resources contribute significant proportions of household income (19% in Angola, 32% in Namibia and 45% in Botswana). In aggregate these resources annually contribute US$60 million to livelihoods in the basin as a whole (US$4.4 million in Angola, US$12 million in Namibia, and US$44 million in Botswana). In terms of direct contribution to all the national incomes, river/wetland-based natural resources in the basin contribute US$100 million annually. In terms of total impact through both direct and indirect contribution to the national income, as well as indirect use values and non-use value, they contribute US$234 million annually. The river/wetland system contributes most of this income through tourism in the lower parts of the basin mostly in Botswana, but household make direct use of wetland resources such as fish, reeds and others.

Future water use developments in the upper parts of the basin, for commercial irrigation, hydroelectric power, and urban use, will significantly reduce the income that people in the basin and its associated economies can derive from natural river/wetland resources. Full development of the river system for these water uses, could over the next 40 years cause long term losses in the direct income earned from river/wetland natural resources amounting to US$65 million in Angola, US$330 million in Namibia, and US$2.1 billion in Botswana. It is estimated that full water use developments might reduce average household livelihoods by 9% in Angola, 13% in Namibia, and 32% in Botswana.

Planning for future development in the basin needs to take these findings into account, aiming to minimise losses, maximise gains, preserve ecosystem integrity and ensure intra-basin payments are made for ecosystem services rendered. Macro-economic cost-benefit analysis should be applied to ensure that developments have comparative advantage, alleviate poverty, and contribute optimally to national welfare.

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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 Transboundary 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, Bióficia 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*
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		Ortmann, Cynthia L.	*Okavango River Basin Technical Diagnostic Analysis: Environmental Flow Module : Specialist Report Country: Namibia: discipline: Water Quality*
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		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

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