Okavango River Basin Technical Diagnostic Analysis: Environmental Flow Module

Final Specialist Report

Country: **Namibia**

Discipline: **Socio-economics**

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ABBREVIATIONS

AIDS	Acquired Immunodeficiency Syndrome
DTM	Digital terrain model
EFA	Environmental flow 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
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
OBSC	Okavango Basin Steering Committee
OKACOM	Permanent Okavango River Basin Water Commission
PRB	Population Reference Bureau
SAM	Social accounting matrix
TDA	Transboundary diagnostic analysis
UN-FAO	Food and Agriculture Organisation of the United Nations

ACKNOWLEDGEMENTS

1 INTRODUCTION

1.1 Background

An Environmental Protection and Sustainable Management of the Okavango River Basin (EPSMO) Project is being implemented under the auspices of the Food and Agriculture Organization of the United Nations (UN-FAO). One of the activities is to complete a trans-boundary diagnostic assessment (TDA) for the purpose of developing a Strategic Action Plan for the basin. The TDA is an analysis of current and future possible causes of transboundary issues between the three countries of the basin: Angola, Namibia and Botswana. The Okavango Basin Steering Committee (OBSC) of the Okavango River Basin Water Commission (OKACOM) noted during a March 2008 meeting in Windhoek, Namibia, that future trans-boundary issues within the Okavango River basin are likely to occur due to developments that would modify flow regimes. The OBSC also noted that there was inadequate information about the physico-chemical, ecological and socioeconomic effects of such possible developments. OBSC recommended at this meeting that an Environmental Flow Assessment (EFA) be carried out to predict possible development-driven changes in the flow regime of the Okavango River system, the related ecosystem changes, and the consequent impacts on people using the river's resources.

The EFA is a joint project of EPSMO and the Biokavango Project. One part of the EFA is a series of country-specific specialist studies, of which this is the socio-economic Report for Namibia.

1.2 Okavango River Basin EFA objectives and workplan

1.2.1 Project objectives

The goals of the EFA are:
- To summarise all relevant information on the Okavango River system and its users, and collect new data as appropriate within the constraints of the EFA
- to use these to provide scenarios of possible development pathways into the future for consideration by decision makers, enabling them to discuss and negotiate on sustainable development of the Okavango River Basin;
- to include in each scenario the major positive and negative ecological, resource-economic and social impacts of the relevant developments;
- to complete this suite of activities as a pilot EFA, due to time constraints, as input to the TDA and to a future comprehensive EFA.

The specific objectives are:

- to ascertain at different points along the Okavango River system, including the Delta, the existing relationships between the flow regime and the ecological nature and functioning of the river ecosystem;
- to ascertain the existing relationships between the river ecosystem and peoples' livelihoods;
- to predict possible development-driven changes to the flow regime and thus to the river ecosystem;
- to predict the impacts of such river ecosystem changes on peoples' livelihoods.
- To use the EFA outputs to enhance biodiversity management of the Delta.
- To develop skills for conducting EFAs in Angola, Botswana, and Namibia.

1.3 Layout of this report

This report contains the following elements: A description of the methods used is followed by a description of the findings including a description of the socio-economic characteristics of the study area, i.e., the Namibian part of the Okavango river basin. This includes delineation of the Namibian basin into integrated units of analysis (IUAs), the identification of river /wetland based natural resource uses, and the identification of the socio-economic indicators for the EFA model. The characteristics of all these indicators are described and this is followed by a description on the responses to scenario flow change in terms of livelihoods and economic contribution.

1.4 Methods for data collection and analysis

The Namibian socio-economic team collated, reviewed and summarised all available published and unpublished information on the social and economic characteristics in the Namibian part 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.

A rapid multidisciplinary field survey was carried out by the TDA/EFA core team, with assistance within each country from the relevant country teams. Among eight target sites in the basin, two in Namibia (Kapako and Popa) 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 following tasks were carried out.

i.   The key social and economic indicator resources, which can be linked to the river and flow changes at each site were identified. These included those of the indicators identified at the EFA Delineation Workshop (fish, reeds, papyrus, floodplain grass and water lilies), that are used at the site.

ii.	Local key informants and/or focus groups regarding the use of the resources in question were identified and located. Interviews were conducted with these. Particular note was taken of harvest techniques, effort (particularly time invested), equipment/gear (capital requirements), input and product prices, spatial and seasonal patterns of use, perceptions about sustainability, and the relative importance of the use to households/users compared to other resource use.

iii.	In interviews and focus group discussions it was determined as far as possible, how all uses and their spatial and seasonal patterns relate to flow conditions. Examples were uses that take place on seasonally on floodplains or uses that depend on particular depth of flow or flood.

iv.	In the discussions with local informants, any signs or local knowledge of any other indicators, such as those for health, culture, social well-being, that may be linked to flows were recorded.

Of the 12 integrated units of analysis (IUAs) delineated as relatively homogeneous socio-economic zones for the whole basin, two were selected for the Namibian basin. These were used to guide data gathering, and as the basis for extrapolation and aggregation of livelihood and economic values.

During the EFA/TDA process, two specific surveys were carried out to address important data gaps. One was a detailed household and community level survey, carried out in the Angolan part of the basin. The results are presented in Saraiva (2009). The other was 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.

The socio-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. The specific national income measure used was *gross national product*.
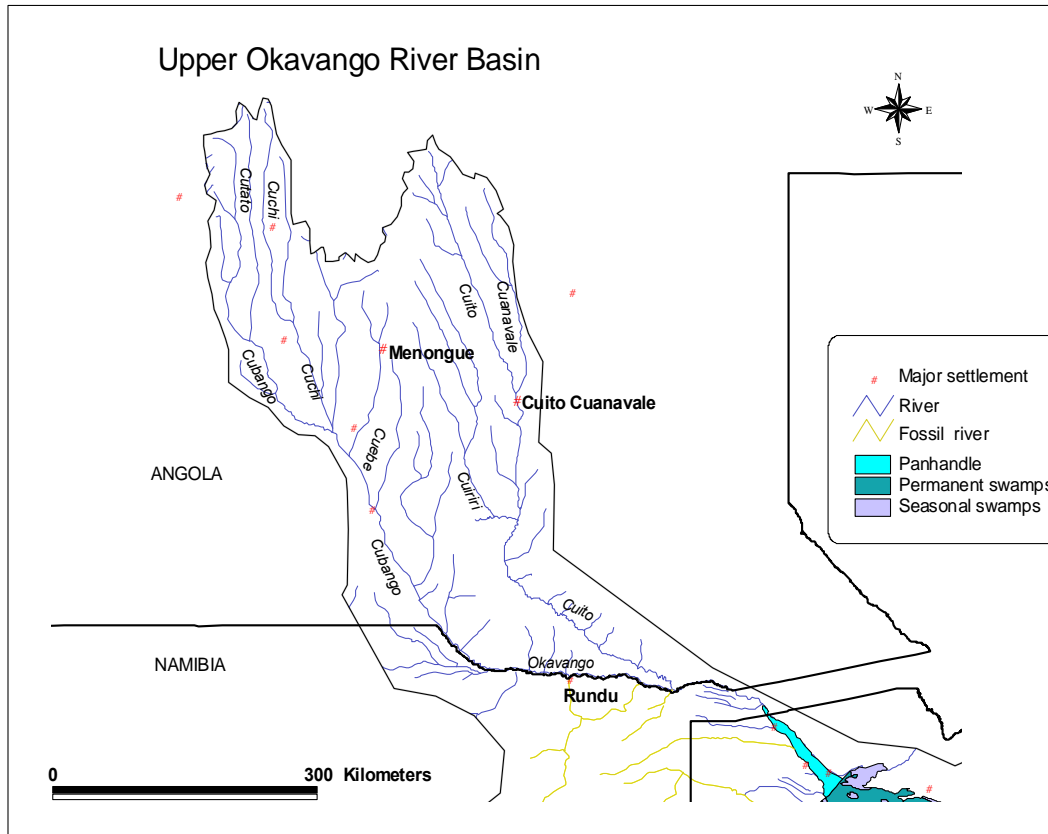
Measurement of the direct contribution to the national income was extended to illustrate the total direct *and indirect* impact of resource use the on national economies. This was done using multipliers calculated from the Namibian social accounting matrix (SAM) model (Lange et al. 2004). National wellbeing as affected by *indirect use values,* or ecosystem services, and national wellbeing as affected by *non-use value* (existence, bequest and option value) was not assessed directly in the EFA process.

In the Namibian basin valuation work, values were first estimated in Namibia dollars *(N$)*. Where impacts of scenarios were compared between scenarios, these values were converted to United States Dollars (US$) to allow basin-wide comparison. During the study in 2008, US$1.00 was worth N$8.16*.*

1.5 Description of the Okavango Basin

The Okavango River Basin consists of the areas drained by the Cubango, Cutato, Cuchi, Cuelei, Cuebe, and Cuito rivers in Angola, the Okavango River in Namibia and Botswana, and the Okavango Delta (Figure 1.). This basin topographically includes the area that was drained by the now fossil Omatako River in Namibia. Outflows from the Okavango Delta are drained through the Thamalakane and then Boteti Rivers, the latter eventually joining the Makgadikgadi Pans. The Nata River, which drains the western part of Zimbabwe, also joins the Makgadikgadi Pans. On the basis of topography, the Okavango River Basin thus includes the Makgadikgadi Pans and Nata River Basin (Figure 1.). This study, however, focuses only on the perennial parts of the basin in Angola and Namibia, and the Panhandle/Delta/Boteti River complex in Botswana. The Omatako and other ephemeral drainages to the south west as well as the and Makgadikgadi Pans and Nata River to the south east are not included.

Figure 1.1: Upper Okavango River Basin from sources to the northern end of the Delta

Figure 1.2: The Okavango River Basin, showing drainage into the Okavango Delta and the Makgadikgadi Pans

1.6 Delineation of the Okavango Basin into Integrated Units of Analysis

Within the Okavango River Basin, no study could address every kilometre stretch of the river, or every person living within the area, particularly a pilot study such as this one. Instead, representative areas that are reasonably homogeneous in character may be delineated and used to representative much wider areas, and then one or more representative sites chosen in each as the focus for data-collection activities. The results from each representative site can then be extrapolated over the respective wider areas.

Using this approach, the Basin was delineated into Integrated Units of Analysis (EPSMO/Biokavango Report Number 2; Delineation Report) by:

- dividing the river into relatively homogeneous longitudinal zones in terms of:
  - hydrology;
  - geomorphology;

- water chemistry;
- fish;
- aquatic invertebrates;
- vegetation;
- harmonising the results from each discipline into one set of biophysical river zones;
- dividing the basin into relatively homogeneous areas in terms of social systems;
- harmonising the biophysical river zones and the social areas into one set of Integrated Units of Analysis (IUAs).

The recognised IUAs were then considered by each national team as candidates for the location of the allocated number of study sites:
- Angola: three sites
- Namibia: two sites
- Botswana: three sites.

The sites chosen by the national teams are given in Table 1.1.

Table 1.1: Location of the eight EFA sites

EFA Site No	Country	River	Location
1	Angola	Cuebe	Capico
2	Angola	Cubango	Mucundi
3	Angola	Cuito	Cuito Cuanavale
4	Namibia	Okavango	Kapako
5	Namibia	Okavango	Popa Falls
6	Botswana	Okavango	Panhandle at Shakawe
7	Botswana	Khwai	Xakanaka in Delta
8	Botswana	Boteti	Chanoga

This report deals only with the Namibian sites as well as their respective IUAs. Namibia was divided into two IUAs each of which, in turn, subdivided into sub IUAs. Thus IUA 8 extended along the basin from the Angolan border post at Katwitiwi to Mukwe, and it was divided into two: 8a - above the junction with the Angolan Cuito tributary, and 8b - below this. IUA 9 extended along the Namibian basin from Mukwe to the Botswana border, and it was also divided into two: 9a - the stretch between Mukwe and the Mahango core area of the Bwabwata National Park, and 9b - the short section of the river wholly within the park. Site 4 at Kapako was representative of IUA 8 and in particular 8a. Site 5 at Popa Falls was representative of IUA 9 in particular 9a.

Functionally, the river basin represented by IUAs 8 and 9 occupies both sides of the river while the river forms the border between Namibia and Angola. There is relatively free movement of people across the river, and resources are used on both sides, but about 80%

of the population lives on the Namibian side, including many Angolans, and nearly all the economic activity is attributable to the Namibian side. From the point of view of the EFA analytical work IUAs 8 and 9 are treated as part of Namibia. Adjustments were only made when extrapolating the values between countries.

# 2   RESULTS - THE SITES

2.1   Overview of Namibian sites

The sites are specific localities, selected primarily so that their hydrological and biophysical characteristics can be measured where needed. They need to be representative not only of the IUA within which they fall, because the information gained from site visits needs to be extrapolated to the whole IUA. Furthermore, this information needs to be suitable for extrapolation to those IUAs which do not have sites. This is particularly the case with the socio-economic component of the EFA, since the impacts of flow change need to be measured in terms of their impact on aggregate household welfare and economic income within the IUAs, the countries, and the basin as a whole.

From the socio-economic perspective the sites provided only reference points where field visits were enabled, but the field literature and research was aimed more at the broader IUA concerned. When the EFA field trip took place in Kavango Region, between the 17th and 23rd of October, 2008, communities in the vicinity of Sites 4 and 5 were interviewed using focus group and key informant methods.

2.1.1   Site 4: Okavango River at Kapako

Site 4 was located 20km upstream from Rundu on the Okavango river and was representative of integrated unit of analysis (IUA) number 8. As stated, IUA 8 stretched from the Angolan border post at Katwitiwi to Mukwe. This part of the river is characterised by having a sandy substrate and a narrow floodplain. The division of IUA 8 into two: 8a - above the junction with the Angolan Cuito tributary, and 8b - below this, reflects the fact that above the Cuito junction, floods are more marked and seasonal river flow more varied. Inflows from the Cuito are more constant and seasonally stable and this stabilises the flow regime in 8b.

Map 2.1 shows the locality of Site 4 at Kapako. Land is state owned with communal use rights, and households live concentrated along the river. The locality of a strip of households can be seen in the map.
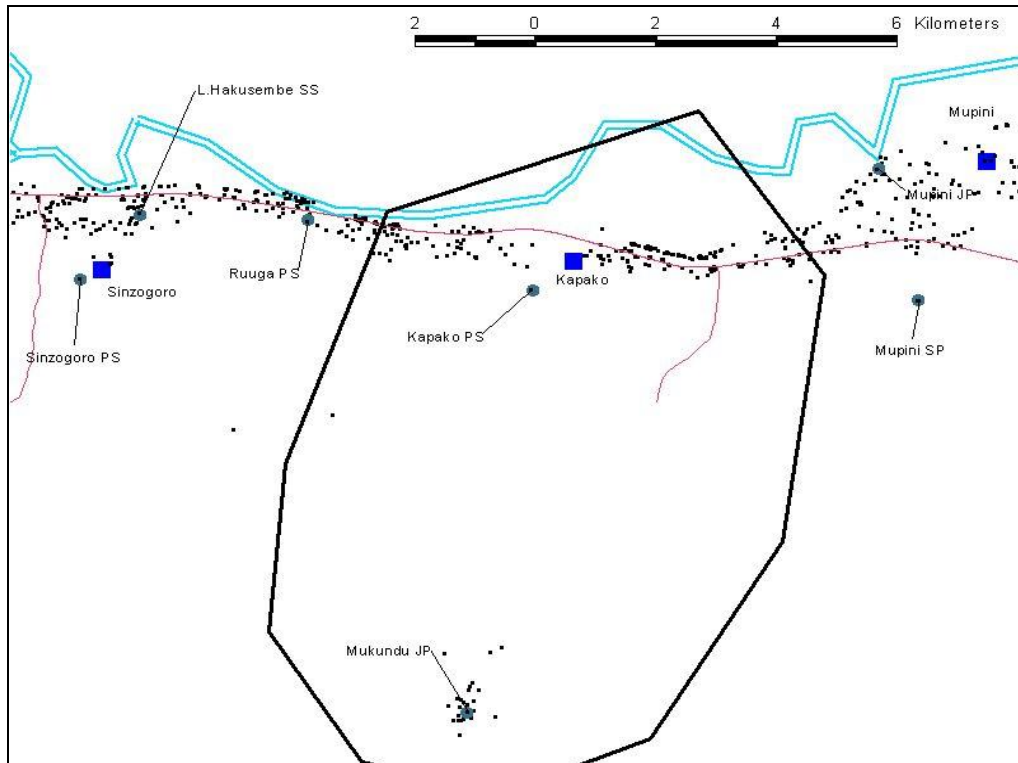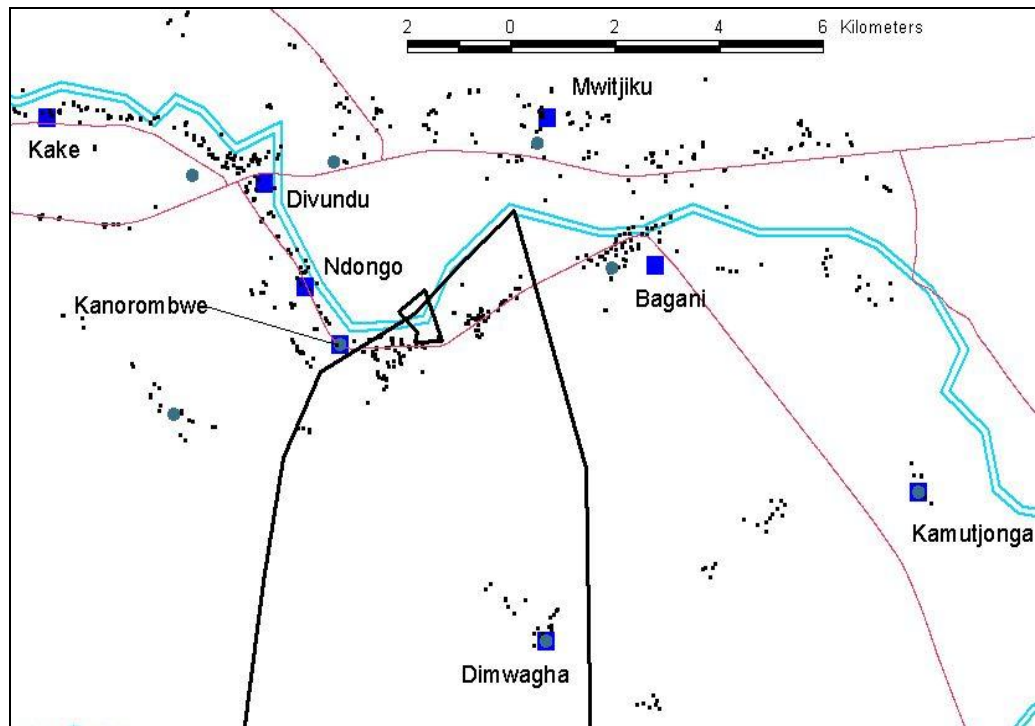
Figure 2.1: Location of Site 4 at Kapako

2.1.2   Site 5: Okavango River at Popa Falls

As stated, Site 5 is representative of the river between Mukwe and the Botswana border at Mohembo or IUA 9. Here the river flows over a mixture of rock and sand and, for most of its length, characteristically does not have a floodplain. It has also been divided into two: 9a - the populated stretch between Mukwe and the Mahango core area of the Bwabwata National Park, and 9b . the section of the river wholly within the park. Section 9b does have a moderately developed floodplain, which in Botswanas IUA 10, downstream widens considerably into the delta panhandle.

Map 2.2 shows the locality of Site 5 at Popa Falls. The land is state owned under communal tenure and households are scattered along the river as in IUA 8. These can be seen in the map.

Figure 2.2: Location of Site 5 at Popa Falls

2.2 Socio-economic description of Namibian sites

2.2.1 Site 4: Kapako

The work of Mendelsohn & el Obeid (2003, 2004) and Mendelsohn et al. (2002) as well as Yaron et al. (1992) provided significant amounts of data relevant to the descriptions that follow.

The floodplain in IUA 8 effectively distinguishes it from IUA 9 which generally has a rocky substrate and no floodplain. The river is at the heart and core of the Okavango Basin, and a variety of aquatic plants animals live in and make good use of the river water. The river channels are often flanked with broader margins consisting of floodplains, particularly so as one progresses down the basin from the source. Away from the rivers and floodplains there are uplands dominated by drier, deciduous woodlands. A variety of organisms are specialised inhabitants of the river channels and floodplains.

The fish communities can be divided into two categories according to food habits, with species that feed on plant materials and species that are predators of other fish. Further fish communities tend to be broadly divided according to habitat, with different fish preferring the mainstream channels, rocky areas and rapids, backwaters, permanent swamps and the

seasonal floodplains. The floodplains are of greatest value as places in which most fish breed.

The floodplains are also of importance for the harvest of other resources. The wetter parts contain reeds, and some papyrus which can be used for construction and crafts manufacture. In permanent pools and backwaters some water lilies can be harvested as food. In the less frequently or heavily flooded floodplain areas, Specific grasses grow which can be harvested for building, and used as grazing. Crops can also be grown on the floodplains, where receding floods, associated water tables, and more fertile, humic soils can provide more favourable conditions than those on the uplands.

The Kavango region, through which the Okavango river flows in Namibia, is state land under communal land tenure. An estimated 219,090 people in 35,120 households are estimated to live in the Namibian part of the Basin, or within some 20 km of the river in Namibia, as demarcated in the EFA/TDA delineation exercise. This amounts to some 80% of the total population of the Kavango region. The river provides water and a number of resources that attract people to settle. Infrastructure in the form of roads and the regional capital, Rundu, are concentrated along the river. Of the estimated 219,090 people, some 94% live within 5 km of the river, on raised river terraces, in a strip served by a river road. Rundu contains 20% of the people. Nearly half of the Namibian basin population speak Rukwangali, with other languages, mostly Rumanyo, Nyemba and Thimbukushu spoken by the rest.

Population growth rates in the Namibian basin population have been very high, up to 7% per annum between 1981 and 1991. This was due in part to the prevalent underdeveloped and rural setting, but also to influx of Angolans from across the river, displaced as a result of civil war and poverty. Some 20% of the Namibian basin population is estimated to be of Angolan origin. Since 1991 there has been a noticeable decline in average fertility rates in the Namibian basin population, from 7.1 children per woman per lifetime, to 4.2. This is due to urbanisation, but also the impact of HIV and AIDS.

Table 2.2 shows the breakdown of the population in the IUAs of the Namibian part of the basin. 98% of the population, or 214,050 people in 34,360 households, reside in IUA 8 which represented by Site 4 at Kapako. 74% of the IUA 8 population is in IUA 8a which contains Site 4.

The population mostly lives on river terraces above the floodplain where soils are more fertile than in the sandy hinterland. Households grow rain-fed crops, graze livestock and harvest woodland products away from the river, as well as making use of river-based resources. Kapako where Site 4 was situated has a population of approximately 2,500 people within 10km.

Table 2.1: Population estimates for the Namibian Okavango river basin

Zone	No. of people	No. of households
Integrated Unit of Analysis 8a (Site 4, Kapako)	157,690	25,720
Integrated Unit of Analysis 8b	56,360	8,640
Integrated Unit of Analysis 9a (Site 5, Popa Falls)	5,040	760
Integrated Unit of Analysis 9b	0	0
Total for Namibian Okavango Basin	219,090	35,120

The rural economy in the in the communal land is dominated by the small scale traditional agriculture sector. Households derive a living from a strategic range of activities, including small scale low input crop production, small scale livestock keeping, harvest of natural plant products, fishing, formal employment and crafts production. Pension payments also contribute to this living. Most agricultural and natural resource harvesting products are consumed directly and only a small amount is traded in markets. Formal employment is gained in government services, tourism, and commercial agriculture.

As stated, most of the population of Kavango Region is within the Namibian part of the Okavango river basin. 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 in IUA 8 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 nations regions, has declined between 1991-1994 and 2001-2004.

The high levels of poverty are associated with high dependency ratios (around 46% of the population is below 15 years, or older than 64 years, of age). A very high rate of HIV infection, as measured among pregnant women visiting hospitals and clinics, has been recorded. This rate rose from 7.5% in 1994 to 20% in 2002 (Mendelsohn & el Obeid 2003).

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. 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 0.56 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 Kavango and IUA 8. 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, is linked to the summer rains and associated standing water. Urinary and intestinal bilharzia are water borne and both prevalent in the river. Their incidence appears to have increased dramatically (Mendelsohn & el Obeid 2003).

Seasonal flooding in February, March and April has a significant impact on the fish populations which spike during this period. Fish catches from floodplain channels are very high during the floods, and they are lower from the river channel in the rest of the year. The floodplain results in a number of other resources being available for household livelihoods. Communities harvest reeds, *Phragmites* sp., from upper wet banks and lower floodplain reaches. They harvest specific grasses for thatching material (notably *Miscanthus junceus*) from lower floodplain and middle floodplain vegetation zones. They grow crops in lower and middle floodplain sites, deriving enhancement of yield from the more humic soils and wetter soils. They also derive some of their livestock grazing in middle and upper floodplain vegetation zones benefitting from enhanced productivity from the moister soils.

Compared with IUA 9 downstream, a higher portion of household income in IUA 8 is derived from harvest of river resources. This is the direct result of the floodplain. IUA 8 also contains an estimated 24 private tourism establishments, sited along the river, about 20 of these are close to Rundu, and another 4 are scattered downstream from this. These facilities host business travellers and leisure tourists passing through Kavango region and they make use of the river and river-associated scenery for their tourism product. Households in the IUA derive some of their income from employment in these facilities. Beyond these household incomes the tourism sector also contributes value added to the national income through private sector profits, taxes and returns to and of capital. The location of Site 4 was representative of the IUA8 with respect to the household harvest of natural resources, but did not contain any tourism establishments which are concentrated in the IUA downstream of this.

Irrigation, mostly undertaken by government agencies and sometimes involving private sector contractors, is practised on some 2,600 hectares at 11 sites along the river, for

commercial crop production. Various high value crops are grown along with staple grains. Better quality soils on the river terraces are used rather than the sandy upland soils. The setting is remote from input and product markets and the financial viability is difficult. Only production dominated by high value cash and horticultural crops is economically attractive (Liebenberg 2009; Shuh et al. 2006) and all require subsidisation. Nevertheless commercial agriculture, at the scale practised, generates very significant income and significant amounts of employment.

Focus group discussions at Kapako, Site 4, confirmed these findings, generally. During the focus group discussion the basin residents described the flooding process where rising river and channel waters push out over flat surrounding ground and the most extensive floods form in years when river levels are highest. Floods provide access for fish to extensive vegetation and detritus for feed and breed. They also offer the young fish refuge from larger, predatory species and greatest survival of young fish and overall increase in fish population occur in years when water levels are high and flooding lasts longest

Local people have recognised the quality of water and fish recourses is decreasing in the Okavango River. Fish remain a significant income source in the lives of people at Kapako, who fish for food or earn incomes by selling their catches or providing trips for tourists. In terms of numbers, the fish stock explodes during flood times. On the flooded plains fish numbers can be four times higher there than in the main river channel. Fish are caught by households using both traditional and modern methods. Traditional gear includes fish funnels, kraal traps, scoop baskets, push baskets, bows and arrows, set fish hooks and spears. Modern gear consists of line and hooks, mosquito nets, and gill and seine nets.

The use of fish for recreational angling forms part of the tourism value associated with the river. However, only a small part of tourism values is attributable to angling. The increase in human population on the southern bank in IUA 8 means that the natural riparian landscape, consisting of the main Okavango river channel and the floodplains are being subjected to considerable pressure. The vegetation along the river bank and floodplain on the Namibian side is heavily grazed and depleted. Thus, at Kapako, the residents graze their livestock across the river on the Angolan floodplain

Despite the increase in grazing pressure and deforestation on the southern bank and although the extent of bare ground has increased residents consider that overall water quality has not declined substantially with the exception of very localised increase in phosphorus concentration and a very slight decrease in water clarity from an increase in suspended sediments. They perceive short term seasonal variation in water quality than long term change.

2.2.2 Site 5: Popa Falls

IUA 9 is relatively small, compared with IUA 8, and it includes significant areas of national park. As a result, and as can be seen from Table 2.2, it contains only 3% of the total population of the Namibia portion of the basin. Many of the socio-economic characteristics associated with the IUA 8 are the same for IUA 9 and Site 5. However the lack of a floodplain in IUA 9 means that many of the benefits that people derive from the river in IUA 8 are absent. Fishing is restricted to the river channel resulting in constant, but relatively lower catches during the year. Use of mokoros (canoes) along with hook-and-line and gill nets is necessary for effective fishing in the main channel. Community representatives, in focus group discussion, confirmed that fishing is a secondary activity for most people in the Popa area, contributing little to the overall cash or in-kind incomes of the majority of households. People thus pay much less attention to fishing than to farming and other activities. Fishing actually declines somewhat during the higher water levels around March as it is more difficult to fish the strongly flowing channel then. Fishing is small-scale and mostly for home consumption. A commercial fishing operation involving drag and gill nets, started by a person, non-resident to the area, was asked to cease operations by the community, demonstrating the existence of some property rights in fishing.

The use of reeds and floodplain grasses is restricted to a very narrow wet bank strip and floodplain crops and floodplain derived grazing are absent. Species used are reed, *Phragmites australis,* for building, the sedge, *Cyperus papyrus* for mats, and the grass, *Miscanthus, junceus* for thatch. Communities in IUA 9 derive a lower proportion of their household income from the harvest of river resources than those in IUA 8. According to community informants interviewed during a focus group meeting at Popa Falls, Site 5, tourism is a major source of income to the Popa residents; most of them are employed within the lodges around Popa area. They value tourism as their major source of income. Indeed estimations confirm that a large proportion of the river-derived incomes for households comes from employment in tourism. There are some 6 private sector tourism lodges and camps which make use of the river and the river associated wildlife in Bwabwata National Park downstream for their tourism product.

As in IUA 8, households reported being dependent on a mix of incomes, including wages, business earnings, pensions and remittances. Households also derive income from small scale livestock keeping, small-scale low-input upland crops, and use of wild upland plant resources for thatch, fuelwood, and poles. Farming activity is considered an important source of income; households engage in both crop and livestock farming activity. Planting is staggered through the rain season and is undertaken after there has been good rainfall. This increases the chance of crop survival during the hot dry periods. Livestock farming is dominated by cattle and goats, which are grazed in upland woodlands under common tenure. They are moved between grazing and sources of water, mainly the Okavango river

2.3   Habitat integrity of the sites in Namibia

The concept of habitat integrity is applied in the socio-economic report in terms of the degree to which natural resource uses are sustainable or not. This was assessed, based on information gleaned from communities during focus group meetings, key informant interviews, discussions with members of the EFA bio-physical team and the literature.

Generally, more so than at all other sites and IUAs in the basin, natural resources harvesting at least in parts of IUAs 8 and 9, is at levels close to or exceeding sustainable limits. Thus livestock grazing pressure on open access uplands and floodplains is very high, deforestation in upland river terraces and woodlands has resulted in reduced woodland cover on the southern bank of the river. In terms of the river-based natural resources, fish are being used at close to the sustainable limits (B. van der Waal, 2008, pers. comm.). Reeds and floodplain grass is being used intensively in most of the IUAs.

Utilisation pressure on natural resource in the populated southern bank of the river, in both IUA 8 and IUA 9, can only increase in the future, as the population grows, at a rate, estimated at between 0.9% and 1.5% per annum (Mendelsohn et al. 2002; Mendelsohn & el Obeid 2003, 2004).

Currently the resources on the north bank of the river in Angola are underutilised, and these are being used increasingly by people based on the southern bank, for example for floodplain grazing, harvesting of reeds, harvesting of grass, etc. The protected Bwabwata National Park in IUA 9 contains a pristine array of resources with significant value as a reservoir for breeding and dispersal, as well as a base for tourism.

During the derivation of response curves in the EFA models during water use scenario analysis, no consideration was given to population growth and the impact that this will have on the resources in question. This was to prevent excessive complexity. However, in the extrapolation of livelihood and economic values to measure impacts during scenario analysis, discounted future streams of values incorporation the effects of future change were used. These included consideration of change driven by population growth.

3   RESULTS - THE INDICATORS

3.1   Indicators

3.1.1   Introduction

Biophysical indicators are discipline-specific attributes of the river system that respond to a change in river flow by changing in their:

- abundance;
- concentration; or
- extent (area).

Social indicators are attributes of the social structures linked to the river that respond to changes in the availability of riverine resources (as described by the biophysical indicators).

The indicators are used to characterise the current situation and changes that could occur with development-driven flow changes.

3.1.2   Indicator list for socio-economics

In order to cover the major characteristics of the river system and its users many indicators may be deemed necessary. For any one EFA site, however, the number of indicators is limited to ten (or fewer) in order to make the process manageable. The full list of socio-economic indicators was developed collaboratively by country representatives for the discipline, and is provided in Figure 1. With a few exceptions all of the indicators are applicable to all of the sites. The exceptions apply where, for example, there is no floodplain of significance, and thus no floodplain grazing or floodplain crop production.

It is important to note 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 would be use of riparian tree fruits. Another is the use of water for irrigated commercial agricultural production. Some 2,610 hectares are irrigated in this way in IUA 8, contributing significant income and employment for local residents. But irrigated crop production would draw water in any case, regardless of flow change. It would also presumably be augmented and expanded as part of the water use scenarios, itself affecting water flow.

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 have been treated only in discussion, despite being recognised as likely to be affected by flow change.

The indicators in Figure 3.1 are divided into those affecting local household income, or livelihoods (1 to 8) as well as the broader economy, and 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. All indicators were considered relevant at Site 4 (IUA 8). At Site 5 (IUA 9) indicator 4 (floodplain crops) and indicator 5 (floodplain grazing for livestock) were not measured due to the general absence of a floodplain.

Table 3.1: List of socio-economic indicators and their links to the broader economy

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				

3.1.3 Description and location of indicators

Socio-economic Indicator 1

Name:	**Household income - fish**
Description:	**Small-scale household-based fishing activity, using traps, and/ or gill nets, hook and line and mokoros (canoes), for own use as fresh food product, and very limited marketing, with very limited processing (drying).**
Representative species:	**Vegetarian and predatory bream (Cichlidae), tiger, barbel (Claridae),**
Flow-related location:	**Channels, floodplains during floods, residual floodplain pools**
Known water needs:	**Perennial flows in channels, regular seasonal floods on floodplains**

Socio-economic Indicator 2

Name:	**Household income - reeds**
Description:	**Small-scale household-based harvesting of reeds using sickles, for own use in housing and compound wall construction, and very limited marketing**
Representative species:	**Reed, *Phragmites australis***
Flow-related location:	**Upper wetbank 1, river lower floodplain**
Known water needs:	**Perennial flows in channels, regular seasonal floods on upper wetbank 1 and river lower floodplain**

Socio-economic Indicator 3

Name:	**Household income – floodplain grass**
Description:	**Small-scale household-based harvesting of grass using sickles for own use as specialised construction thatch and very limited marketing**

Representative species: Thatch grass, *Miscanthus junceus*, other species

Flow-related location: River lower floodplain, river middle floodplain

Known water needs: Regular seasonal floods on floodplains

Socio-economic Indicator 4

Name: Household income – floodplain gardens (e.g. molapo)

Description: Small-scale household-based flood-recession crop production using animal draft power and manual labour, on floodplains for own consumption as food and very limited marketing and with home milling, complementary to household upland rain-fed crop production.

Representative species: Maize, sorghum, millet, vegetables

Flow-related location: River lower floodplain, river middle floodplain

Known water needs: Regular seasonal floods on floodplains and regular transitional season 2 to allow crop growth

Socio-economic Indicator 5

Name: Household income and wealth - livestock

Description: Small-scale household-based open access grazing of livestock on floodplain as part of broader upland small-scale livestock keeping for meat milk, transport and as a store of wealth, with limited marketing

Representative species: Local breeds of cattle (*Bos indicus*) and goats

Flow-related location: River middle floodplain and river upper floodplain

Known water needs: Regular seasonal floods on floodplains

Socio-economic Indicator 6

Name: **Household income - tourism**

Description: **Household-based and migratory, full- and part-time employment in local tourism industry as labour, skilled labour, and occasionally management**

Representative species: **General wildlife, including semi aquatic animals, lower, middle, and outer floodplain grazers, associated predators and birds generally, general scenic habitats and attributes linked to a mosaic of all the vegetation indicators**

Flow-related location: **Sited commonly on upper dry banks but making use of all vegetation indicators as part of product – dependent on dry season low flow and flood volume**

Known water needs: **Perennial flows in channels, regular seasonal floods on floodplains**

Socio-economic Indicator 7

Name: **Potable water/water quality**

Description: **Small-scale household-based use of river water for household needs**

Representative species: **None – water quality indicators generally**

Flow-related location: **Channels, floodplains during floods, residual floodplain pools**

Known water needs: **Perennial flows in channels, good water quality**

Socio-economic Indicator 8

Name: **Wellbeing/welfare from intangibles**

Description: **Small-scale household-based welfare linked to income from indicators 1 to 7 but also to general individual, household and community feeling on ecosystem integrity in the face of flow change**

Representative species:	None specific, but linked to indicators 1 to 7 as well as overall ecosystem integrity
Flow-related location:	Channels, floodplains, all habitats associated with ecosystem integrity
Known water needs:	Perennial flows in channels, regular seasonal floods on floodplains

Socio-economic Indicator 9.1

Name:	Macro-effects from tourism income, excluding household income (including multipliers)
Description:	Medium to large scale lodge based, non-consumptive wildlife viewing and some consumptive hunting or angling tourism, hosting middle- and up-market foreign and regional tourists for water and/or land-based activities
Representative species:	General wildlife, including semi aquatic animals, lower, middle, and outer floodplain grazers, associated predators and birds generally, general scenic habitats and attributes linked to a mosaic of all the vegetation indicators
Flow-related location:	Sited commonly on upper dry banks but making use of all vegetation indicators as part of product – dependent on dry season low flow and flood volume
Known water needs:	Perennial flows in channels, regular seasonal floods on floodplains

Socio-economic Indicator 9.2

Name:	Macro-effects from household income 1-6, (including multipliers, etc)
Description:	All small-scale household-based activities described under indicators 1 to 6
Representative species:	All species, ecosystems, attributes listed under indicators 1 to 6

Flow-related location: All locations described under indicators 1 to 6

Known water needs: perennial flows in channels, regular seasonal floods on floodplains

Socio-economic Indicator 9.3

Name: Indirect use

Description: Indirect use values, i.e., off-site local, national, regional, or global use values associated with river-based ecosystem services, including carbon sequestration, wildlife refuge, groundwater recharge, flood attenuation, scientific and educational value, among others etc., poorly studied

Representative species: General ecosystem integrity, providing the range of ecosystem services referred to above

Flow-related location: No specific location – associated with a range of geo-morphological and ecological features, including vegetation and wildlife, which affect seasonal flooding patterns as well as perennial nature of flow

Known water needs: Perennial flows in channels, regular seasonal floods on floodplains, generally

Socio-economic Indicator 9.4

Name: Non-use

Description: Existence bequest and option values for preservation, manifested as local, national, regional and global willingness to pay for preservation of resources in the river system, values poorly researched and/or known

Other characteristics: General wildlife, including semi aquatic animals, lower, middle, and outer floodplain grazers, associated predators and birds generally, general scenic habitats and attributes linked to a mosaic of all the vegetation indicators

Flow-related location: Embracing the broader ecosystem including all the vegetation and wildlife indicators, mostly in the better known lower parts of the basin (Okavango delta)

Known water needs: Perennial flows in channels, regular seasonal floods on floodplains

3.2 Flow categories – river sites

One of the main assumptions underlying the EF process to be used in the TDA is that it is possible to identify parts of the flow regime that are ecologically relevant in different ways and to describe their nature using the historical hydrological record. Thus, one of the first steps in the EFA process, for any river, is to consult with local river ecologists to identify these ecologically most important flow categories. This process was followed at the Preparation Workshop in September 2008 and four flow categories were agreed on for the Okavango Basin river sites:

- Dry season
- Transitional Season 1
- Flood Season
- Transitional Season 2.

Tentative seasonal divisions for river Sites 1-5 are shown in Figure 3. to Figure . These seasonal divisions will be formalised by the project hydrological team in the form of hydrological rules in the hydrological model. In the interim they provide useful insights into the flow regime of the river system suggesting a higher within-year flow variability of the Cuebe River and a higher year-on-year variability of the Cubango River.

It is planned to use similar flow seasons for the remaining river sites: 6 and 8.
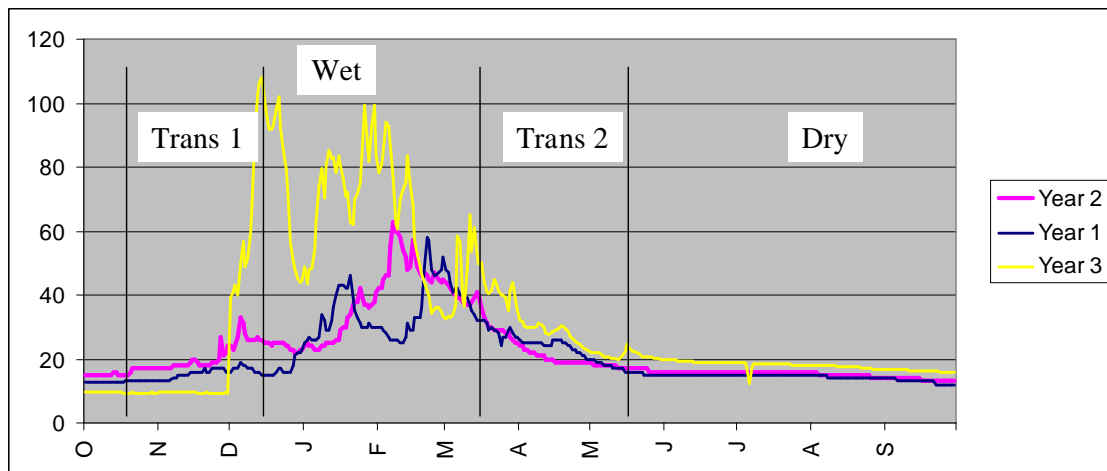
Figure 3.1: Three representative years for Site 1: Cuebe River @ Capico, illustrating The approximate division of the flow regime into four flow seasons
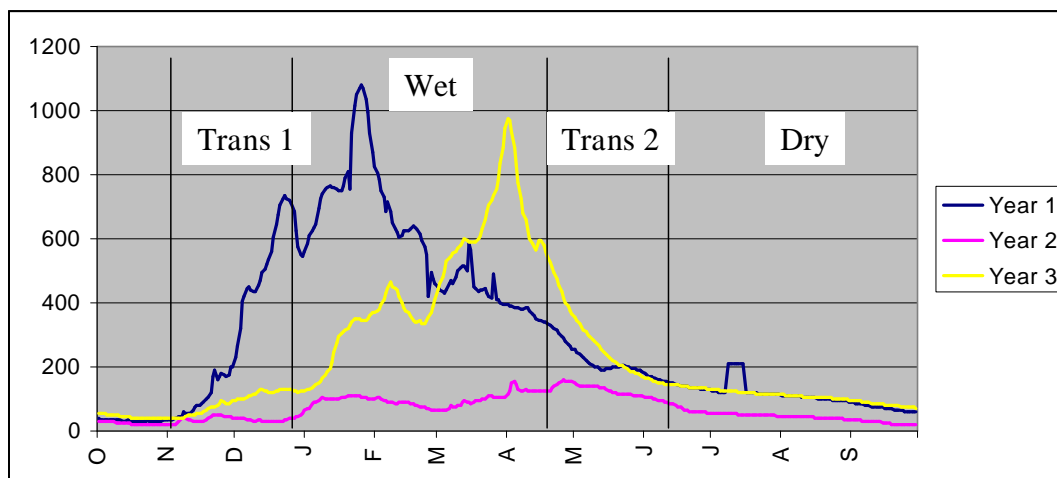
Figure 3.2: Three representative years for Site 2: Cubango River @ Mucundi, illustrating the approximate division of the flow regime into four flow seasons
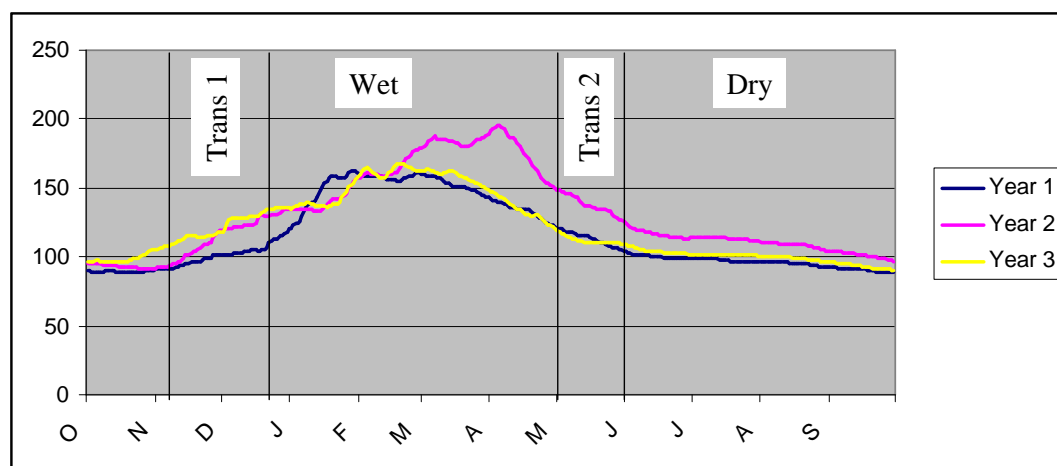
Figure 3.3: Three representative years for Site 3 Cuito River @ Cuito Cuanavale, illustrating the approximate division of the flow regime into four flow seasons
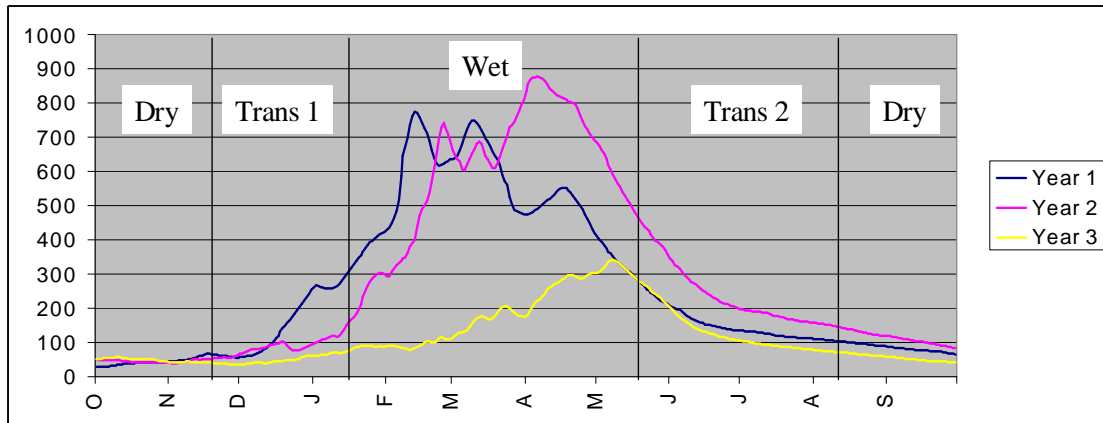
Figure 3.4: Three representative years for Site 4: Okavango River @ Kapako (hydrological data from Rundu), illustrating the approximate division of the flow regime into four flow seasons
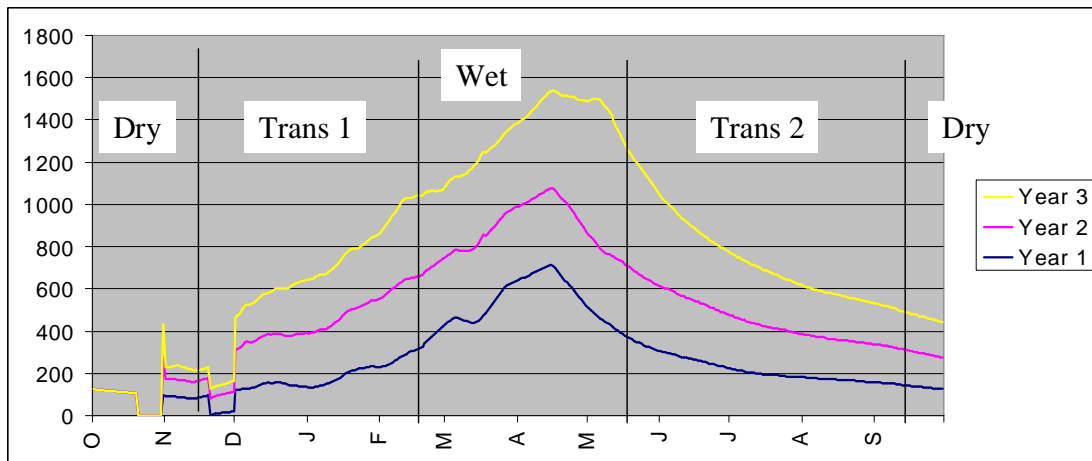
Figure 3.5: Three representative years for Site 5: Okavango River @ Popa (hydrological data from Mukwe), illustrating the approximate division of the flow regime into four flow seasons

The data collection and analysis exercises were focused on addressing what is initially expected to be nine main questions related to these flow seasons (Table 3.2).

Table 3.2: Questions addressed at the Knowledge Capture Workshop, per indicator per site. In all cases, 'natural' embraces the full range of natural variability

Question number	Season	Response of indicator if:
1	Dry Season	Onset is earlier or later than natural mode/average
2		Water levels are higher or lower than natural mode/average
3		Extends longer than natural mode/average
4	Transition 1	Duration is longer or shorter than natural mode/average - i.e. hydrograph is steeper or shallower
5		Flows are more or less variable than natural mode/average and range
6	Flood season	Onset is earlier or later than natural mode/average – synchronisation with rain may be changed
7		Natural proportion of different types of flood year changed
8	Transition 2	Onset is earlier or later than natural mode/average
9		Duration is longer or shorter than natural mode/average – i.e. hydrograph is steeper or shallower

4 RESULTS - RESPONSES AND IMPACTS

4.1 Socio-economic responses to potential changes in the flow regime

The socio-economic discipline differs to some extent from the biophysical ones, in that the ultimate answer is not simply how much of an indicator natural resource there, but how much does a change impact on livelihoods and on the economy. First the status of the particular natural resource or attribute contributing to the livelihood and economic income is taken into account. This usually comes out of biophysical response to flow change. If the example of fish is taken, the abundance and availability of fish for fish catch may respond to change in flood season flood type. The first socio-economic response curve follows this by measuring how fish catches respond to fish abundance. In the example, if fish abundance rises dramatically, fishers may only be able to catch some of these by virtue of limits to their capacity and or the markets.

The second stage in the socio-economic process can be seen as the valuation of fish catch within the fishing enterprise. Thus the short term response to change in fish catch is measured in terms of private net income (livelihood), and contribution made to national economic income (economic impact). This done using financial and economic budget cost benefit models for fishing enterprises. Thus response curves for livelihoods and national income contribution are made.

The socio-economic responses are thus related to resource abundance/availability and not directly related to the flow categories in the previous section except in a few cases. One such case is in the tourism sector which benefits from a complex array of natural attributes. Operators are each faced with a unique and complex set of flow/flood characteristics. These differ, depending on things like if they are on river bank, wetter middle delta or in the drier lower delta, and if they specialise in water-based and/or land-based products or both. Nearly every lodge site has permanently, frequently, occasionally, and rarely flooded areas of varying quantity and in a complex mosaic, and this makes up their tourism product (along with all the other attributes of the site). Here key to success are the abundance of wildlife, the degree and nature of flooding and the dry season low flow characteristics. Tourism is important in the basin and most important for the response curves is an understanding of how flow/flood changes are likely to affect tourism income in the short to long term. As part of the TDA process, a simple survey was conducted among some 50 tour operators in Botswana. This was focused on their perceptions on how flow/flood changes (*in ceteris parabis*), might affect tourism. Mbaiwa & Mmopelwa (2009) give the results of this.

Table 4.1 shows how these flow categories can affect tourism numbers, and thus the socio-economic values.

Table 4.1: Predicted response to possible changes in the flow regime of tourism numbers in the Okavango River ecosystem

Question number	Season	Possible flow change	Predicted response of indicator	Confidence in prediction (very low, low, medium, high)
1	Dry Season	Onset is earlier or later than natural	**Small effect**	
2		Water levels are higher or lower than natural	**The dry season low flow is expected to reduce tourism volumes (tourism numbers) if it drops to very low levels.**	
3		Extends longer than natural	**Small effect**	
4	Transition 1	Duration is longer or shorter than natural - i.e. hydrograph is steeper or shallower	**Nil**	
5		Flows are more or less variable than natural	**Nil**	
6	Flood season	Onset is earlier or later than natural . synchronisation with rain may be changed	**Small effect**	
7		Natural proportion of different types of flood year changed	**The degree and nature of flooding measured primarily in terms of volume and level have important effects on the amount of permanent, frequently, occasionally, and rarely flooded land in the tourism concessions. This affects the amount of tourism with both high floods and low floods generally having detrimental short term impacts.**	
8	Transition 2	Onset is earlier or later than natural	**Nil**	
9		Duration is longer or shorter than natural . i.e. hydrograph is steeper or shallower	**Nil**	

The scenarios which were tested in the environmental flows assessment (EFA) model were four; the 'present day' plus three alternative water use development scenarios. The **present day (PD)** 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 (Low Dev)** 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 (Med Dev)** 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 (High Dev)** 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.

Below, response curves from the EFA model are presented, for all the socio-economic indicators at the two study sites in the Namibian basin. The EFA analysis, though the response curves, captures the short term changes in the socio-economic livelihoods and economic contributions. It does not deal with the longer term question of how communities and investors in river/wetland natural resource use will adapt to changes in the flow. The EFA process thus contained a further step where prediction of future changes in resource uses and their socio-economic values was made. These future streams of value extended over 40 years and were discounted, at a 4% discount rate, to measure the net present value (NPV). These NPVs 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 Namibia. Tourism demand was anticipated to grow at 5% per annum on average in all scenarios. Where tourism was found to collapse in the short term it was assumed to adapt, with its output settling at between 5% and 25% depending on the scenario. 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. The Bar charts below which show long term impacts incorporate all these considerations.

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 as the critical measure to value change as discussed below.

5 VALUES AND FLOW-RESPONSE RELATIONSHIPS IN THE OKAVANGO EFA MODEL

5.1 Base values

Current aggregate values estimated for the household income derived from each socio-economic indicator in the Namibian basin are shown in Figure 5.1. It is clear that tourism is an important river/wetland based contributor to livelihoods, while fish and floodplain grass are also important. Aggregate livelihood values for each of the two IUAs (8 and 9) in the Namibian basin are shown in Figures 5.2 and 5.3. IUA 8 has livelihood characteristics more typical of the Namibian river as a whole. In IUA 9, which does not have a floodplain and is partly occupied by protected area, the river/wetland-based livelihoods are dominated by tourism.

Figure 5.4 shows the aggregate direct and indirect economic contribution to the national income derived from use of those resources constituting the socio-economic indicators in the Namibian basin. Here the picture is similar to that for livelihoods, except that the values are much higher, and the share attributable to tourism is greater. The values are higher because **all** income is measured, not just that accruing to households, and the multiplier effect is included. The multiplier effect reflects the impact of these uses and the broader economy. It is greater for tourism than it is for the other river/wetland based resource uses.
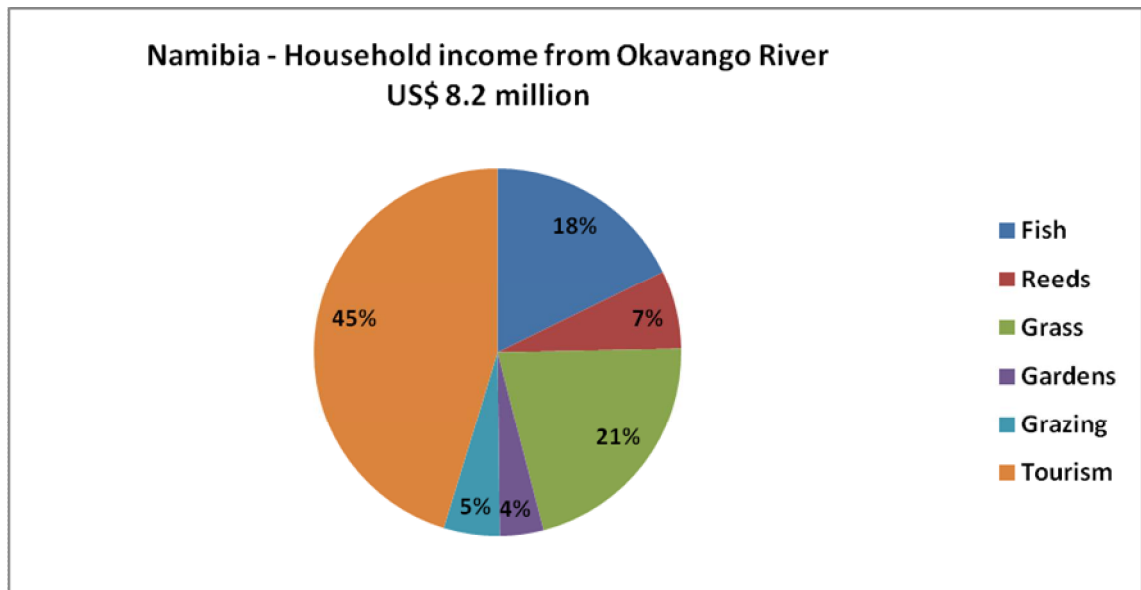
Figure 5.1: Estimated *livelihood* value of Okavango river/wetland based natural resource use in *Namibia* in 2008 (US$1.00 = N$ 8.16)
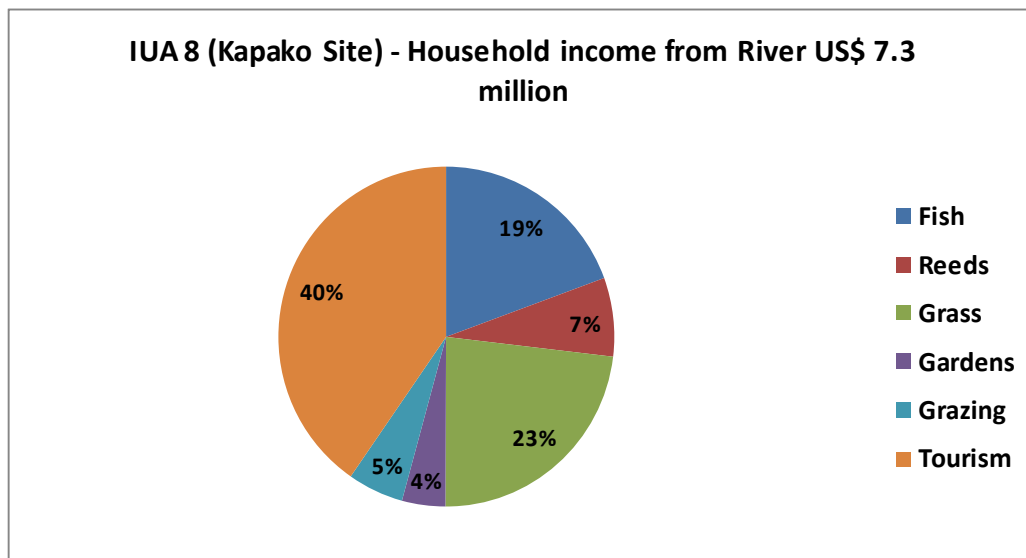
Figure 5.2: Estimated *livelihood* value of river/wetland based natural resource use in *IUA 8 in Namibia*, 2008 (US$1.00 = N$ 8.16)

IUA 9 (Popa Site) - Household Income from River
US$837,000

Fish · Reeds · Grass · Gardens · Grazing · Tourism

4% · 1% · 5% · 1% · 1% · 88%
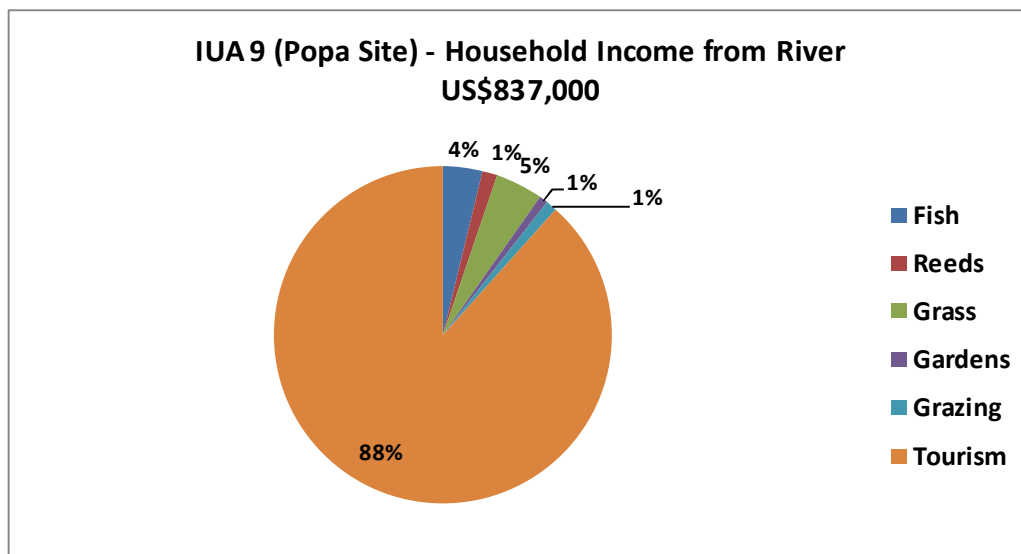
Figure 5.3: Estimated *livelihood* value of river/wetland based natural resource use in *IUA 9 in Namibia*, 2008 (US$1.00 = N$ 8.16)

Namibia - Total Economic Impact of Okavango River
US$43 million

Fish · Reeds · Grass · Gardens · Grazing · Tourism · Function · Non-use

1% · 10% · 3% · 10% · 1% · 2% · 61% · 12%
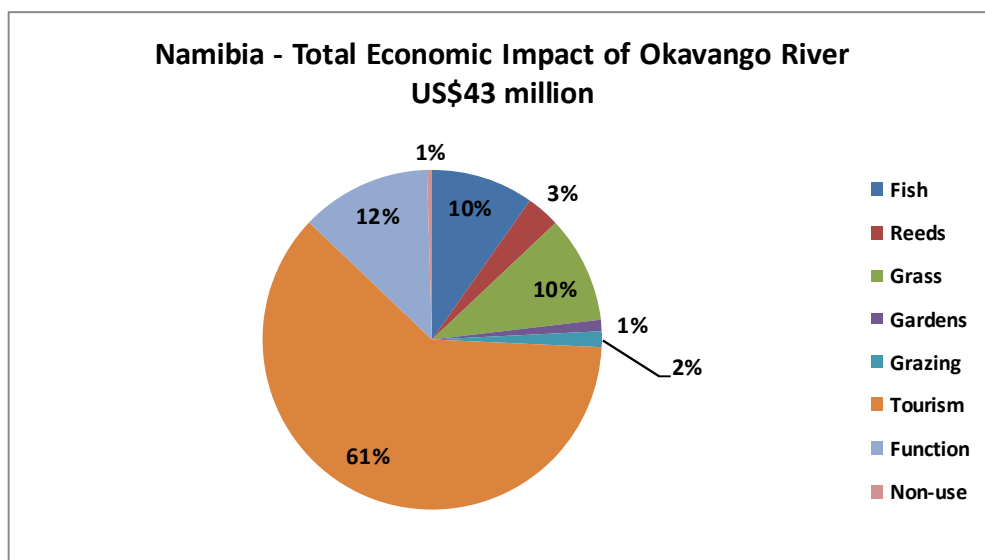
Figure 5.4: Estimated total *direct and indirect impact* of Okavango river/wetland based natural resource use in the Namibian basin on the *Namibian economy* in 2008 (US$1.00 = N$ 8.16)

5.2 Flow responses

Indicator 1 - Fish

KAPAKO - IUA 8 - Study site 4

Fishing at present day is near biological capacity. Floodplain here allows annual large increases in fish abundance. Large changes will be only partly matched in catch by volume, but demand will rise with some commercialisation. Decrease in fish abundance will result in some over harvesting but this is offset by lower ability to catch.

Fish catch response to fish abundance (% of present day)

Household net income response to fish catch (N$ per household per annum)
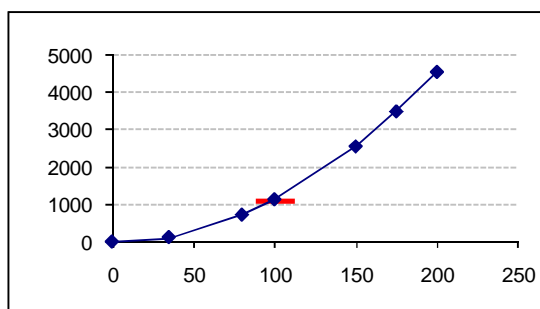
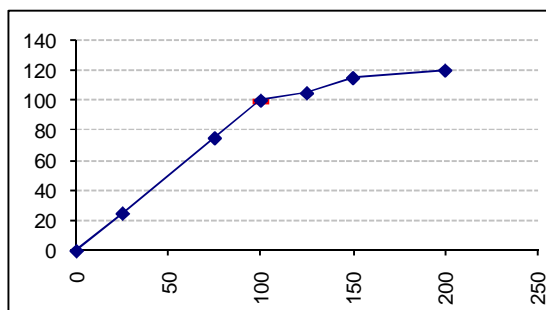Economic impact response to fish catch (N$ per household per annum)
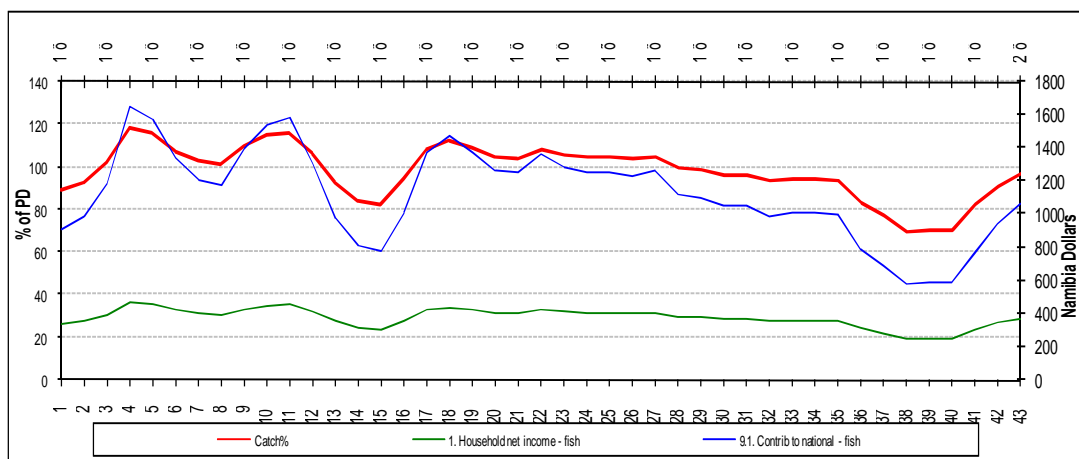
Changes in fish catch, livelihood and total economic impact in last 43 years
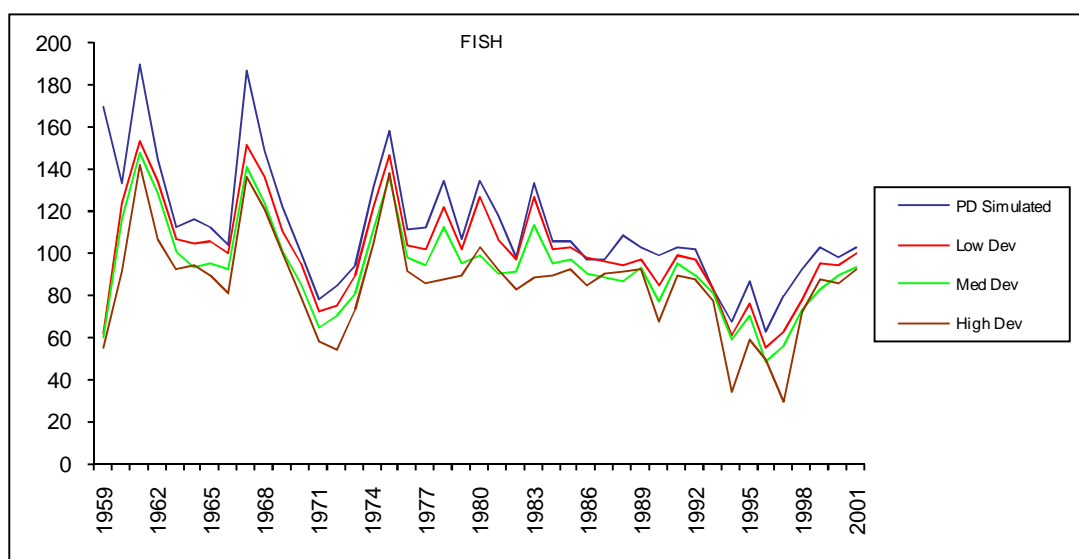
Simulated fish catch response to scenarios over last 43 years
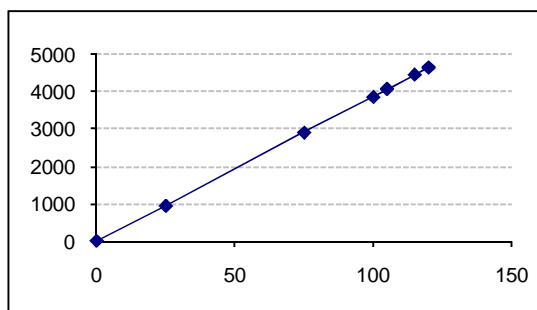
POPA - IUA 9 - Study site 5

Lack of floodplain at Popa means fish abundance more stable than at Kapako. Fishing at present day is close to capacity at lower fish abundance, communities in the area enforce a local policy prohibiting commercial fishing. Decrease in fish abundance will result in some over harvesting but this is offset by lower ability to catch.

Fish catch response to fish abundance (% of present day)

Household net income response to fish catch (N$ per household per annum)

Economic impact response to fish catch (N$ per household per annum)

Changes in fish catch, livelihood and total economic impact in last 43 years

Simulated fish catch response to scenarios over last 43 years

Namibia - Effect of scenario on household fish income - US$
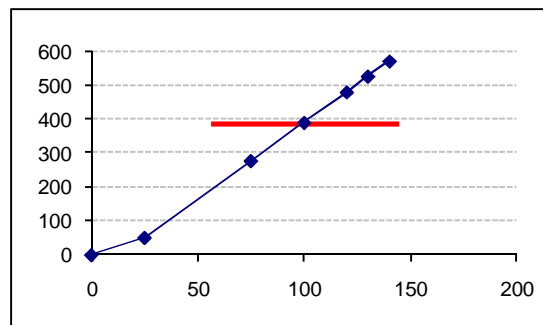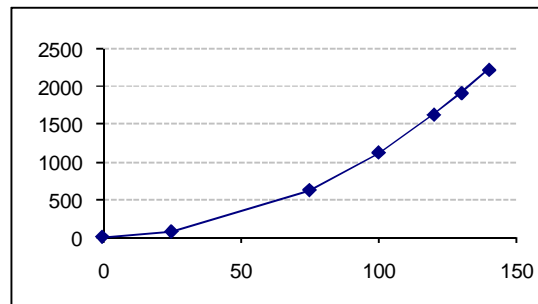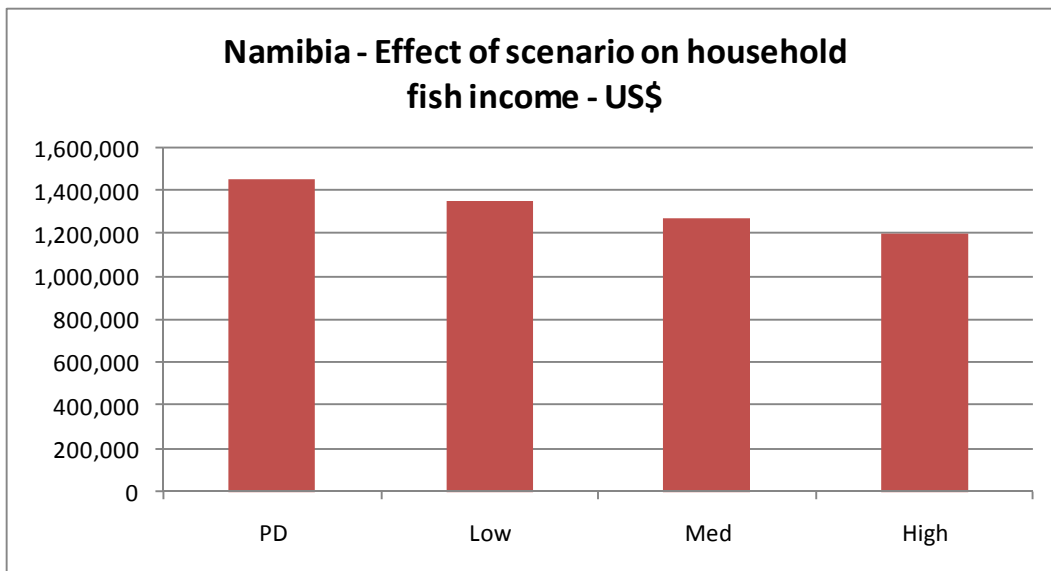
Aggregate short term effect of scenario on livelihoods from fish in Namibian basin (US$/annum, where US$1.00 = N$8.16)

Namibia fish direct economic contribution 40 year NPV @ 4% (US$)
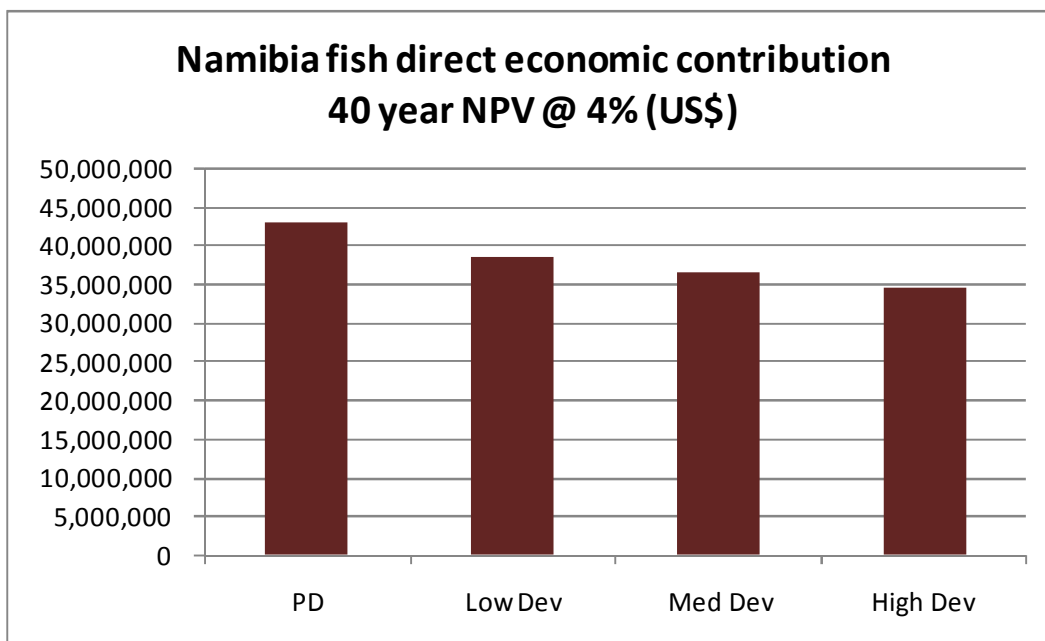
Aggregate long term effect of scenario on direct economic impact from fish in Namibian basin (US$, 40 year NPV @ 8%, where US$1.00 = N$8.16)

Indicator 2 - Reeds

KAPAKO - IUA 8 - Study site 4

The PD demand exceeds supply. With decreasing area the full amount available is harvested. With increasing area harvest is also likely to increase but will tapers off with demand. Reeds harvested both on wet banks and middle floodplain
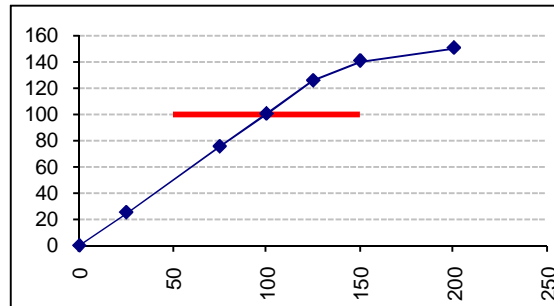
Reed harvest response to reed abundance on wet bank (% of present day)
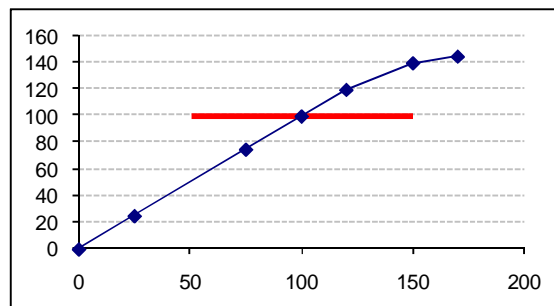
Reed harvest response to reed abundance on middle floodplain (% of present day)
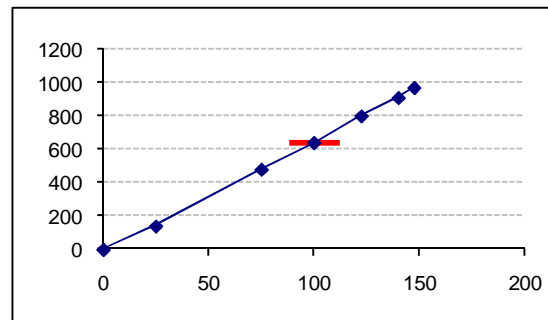
Household net income response to reed harvest (N$ per household per annum)
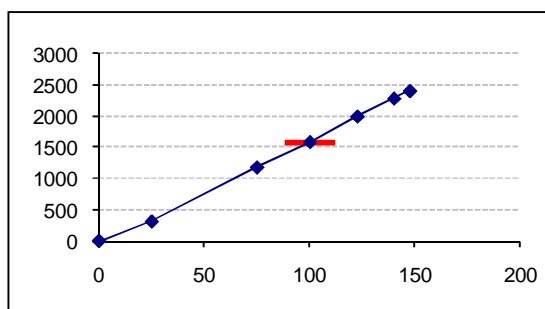
Economic impact response to reed harvest (N$ per household per annum)
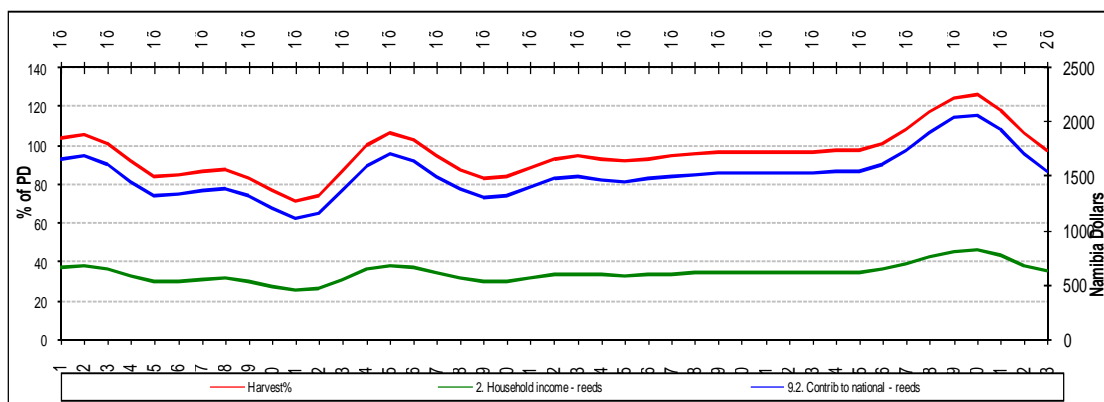
Changes in reed harvest, livelihoods and total economic impact on in last 43 years
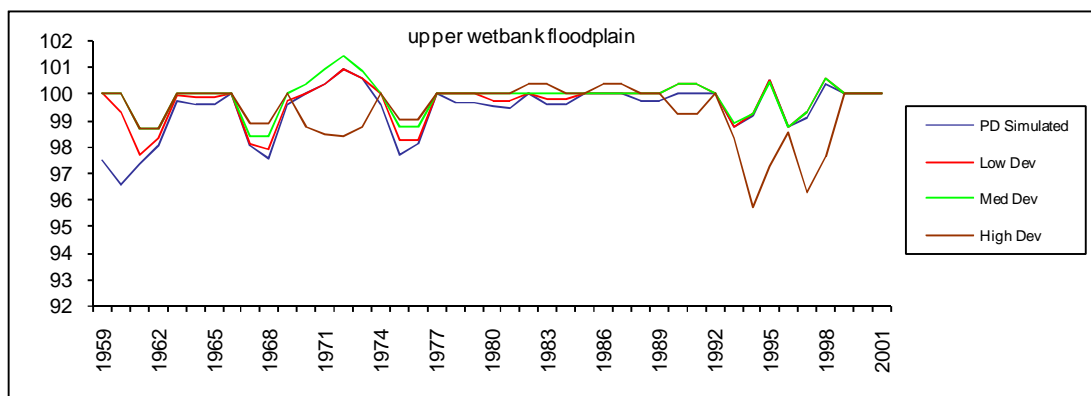
Simulated reed harvest response to scenarios on wet banks over last 43 years
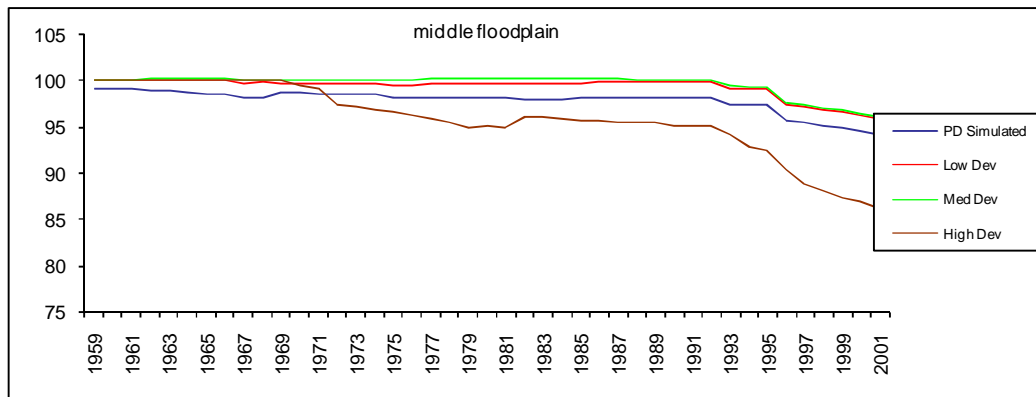
Simulated reed harvest response to scenarios on middle floodplains over last 43 years
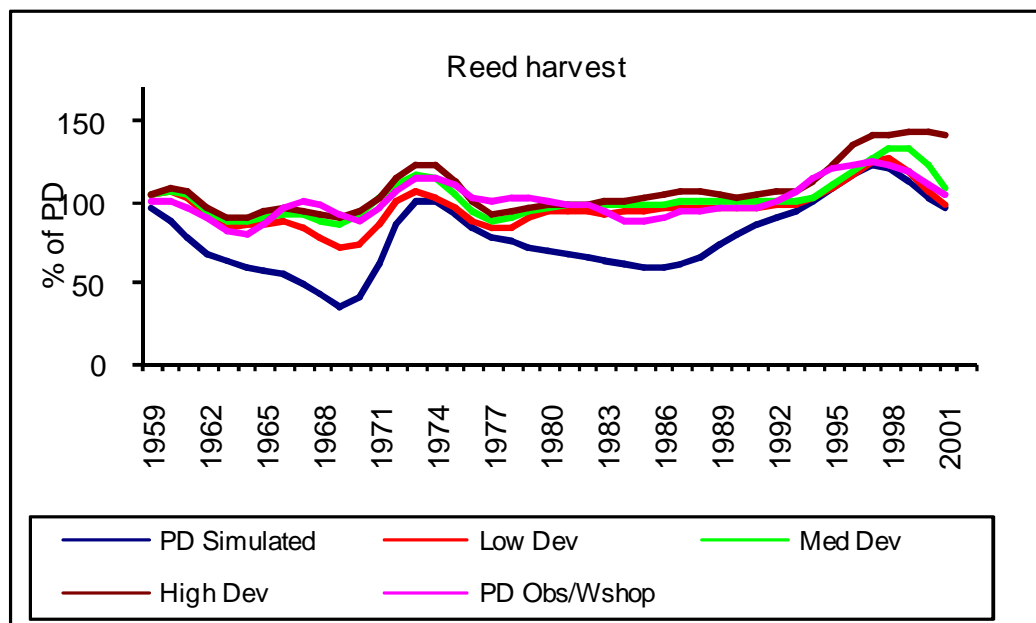
Simulated general reed harvest response to scenarios over last 43 years

POPA - IUA 9 - Study site 5

Lack of floodplain at Popa means reeds only available on upper wet-banks. Used to capacity on south bank, but availability of reeds is high in the northern upper wet-bank, which area is partly protected and difficult to access

Reed harvest response to reed abundance (% of present day)
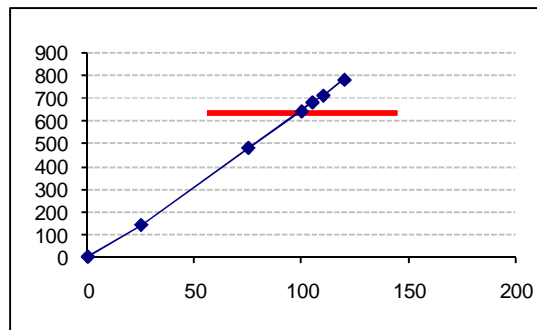
Household net income response to reed harvest (N$ per household per annum)

Economic impact response to reed harvest (N$ per household per annum)

Changes in reed harvest, livelihood and total economic impact in last 43 years

Reed harvest

Simulated reed harvest response to scenarios over last 43 years

Namibia reeds direct economic contribution 40 year NPV @ 4% (US$)
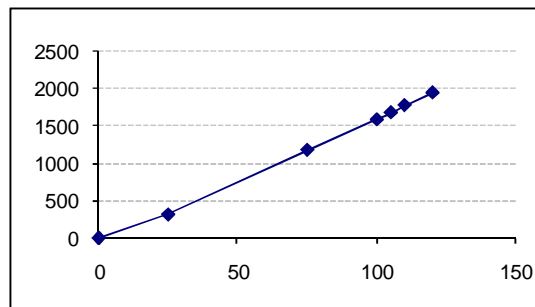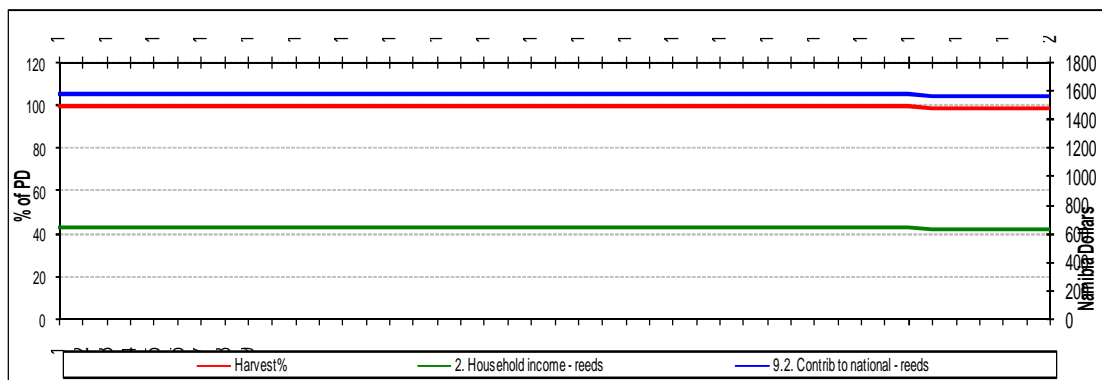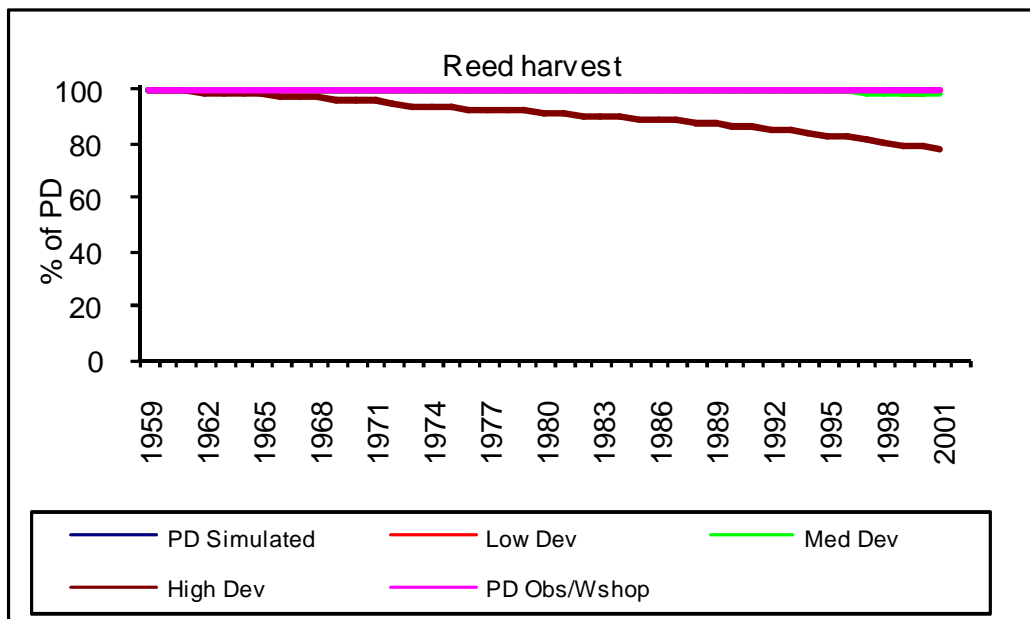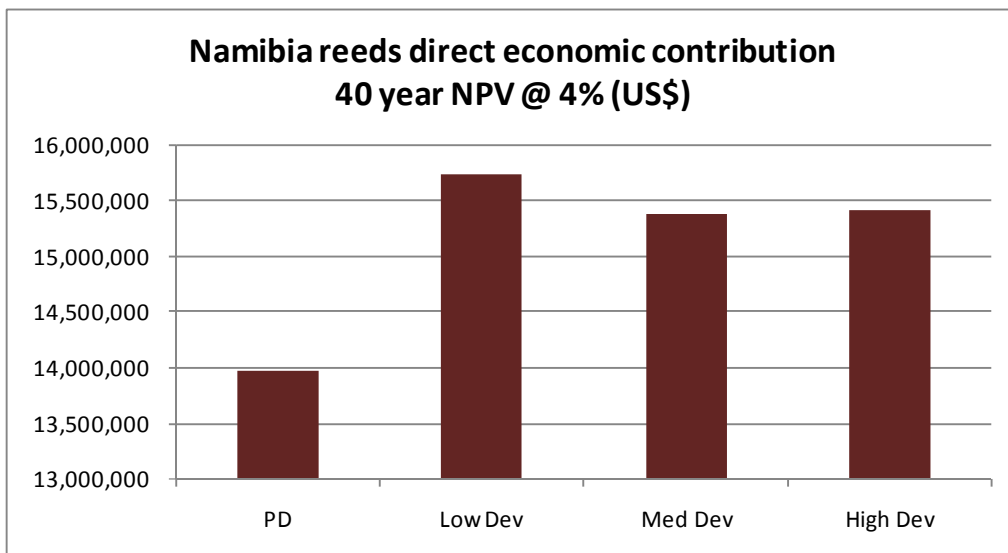
Aggregate long term effect of scenario on long term direct economic impact from reed harvest in Namibian basin (US$, 40 year NPV @ 8%, where US$1.00 = N$8.16)

Indicator 3 - Floodplain grass

KAPAKO - IUA 8 - Study site 4

The present day demand exceeds supply. With decreasing area the full amount available will be harvested. With increasing area, harvest increases but tapers off with demand. Grass harvested both on middle and upper floodplain
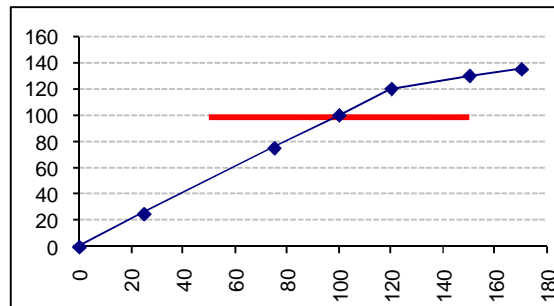
Grass harvest response to grass abundance on middle floodplain (% of present day)
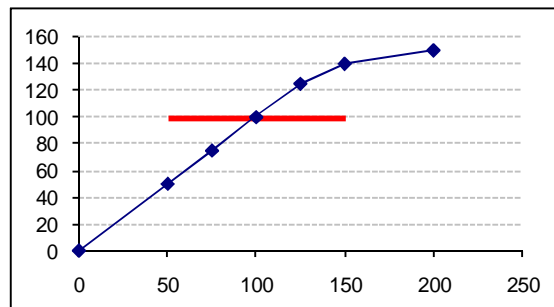
Grass harvest response to grass abundance on upper floodplain (% of present day)
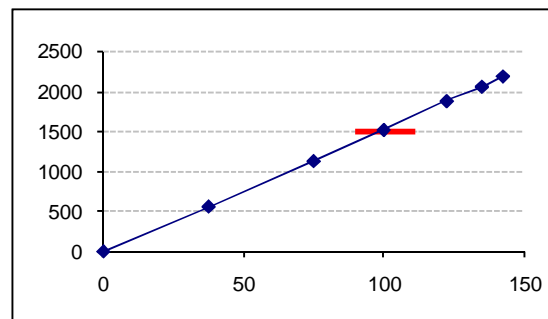
Household net income response to grass harvest (N$ per household per annum)
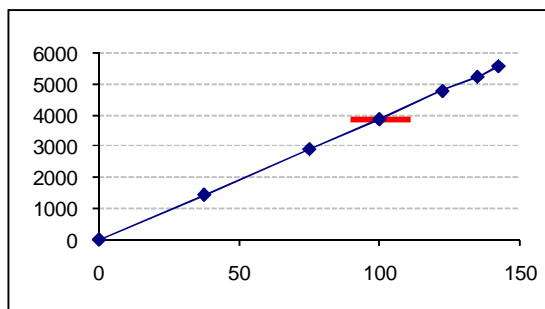
Economic impact response to reed harvest (N$ per household per annum)
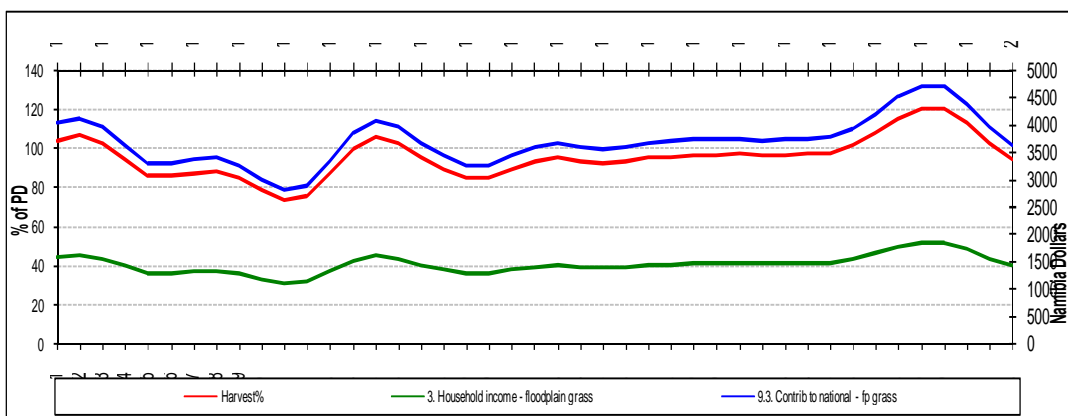
Changes in grass harvest, livelihoods and total economic impact on in last 43 years
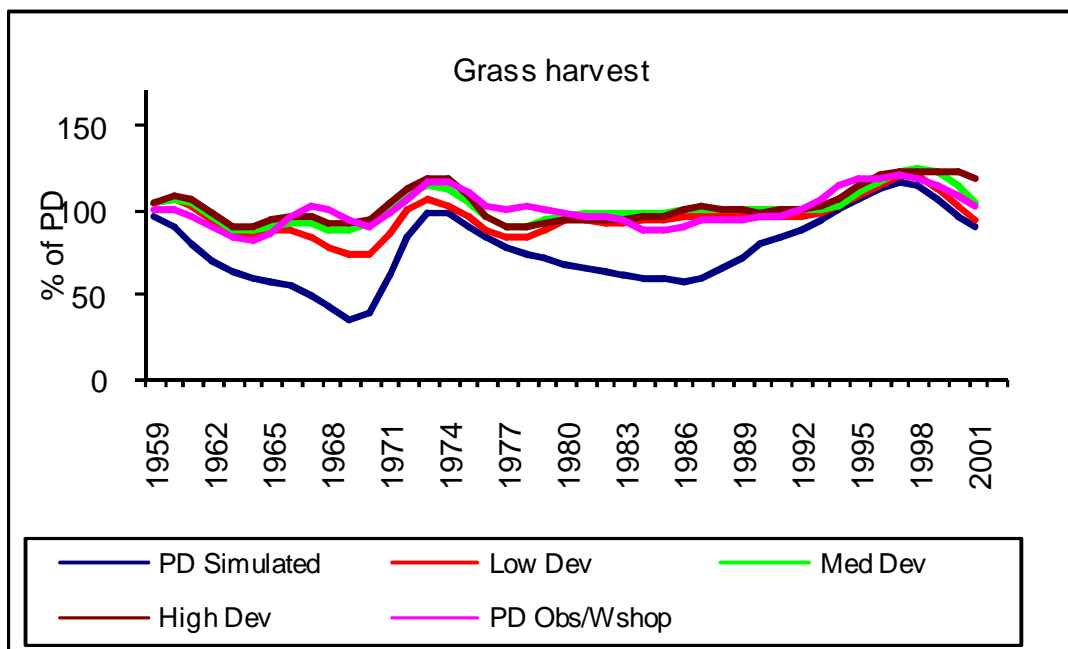
Simulated grass harvest response to scenarios over last 43 years

POPA - IUA 9 - Study site 5

Lack of floodplain at Popa means grass only available on upper wet-banks. Used to capacity on south bank, but availability of grass is high in the northern upper wet-bank, which area is partly protected and difficult to access

Grass harvest response to grass abundance (% of present day)
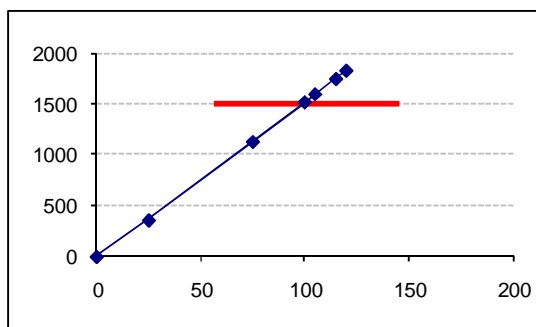
Household net income response to grass harvest (N$ per household per annum)

Economic impact response to grass harvest (N$ per household per annum)
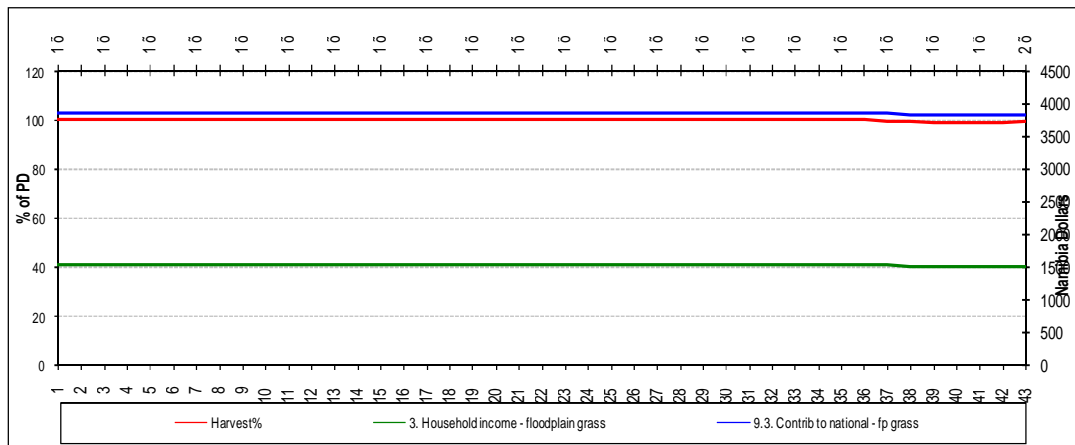
Changes in grass harvest, livelihood and total economic impact in last 43 years

Simulated grass harvest response to scenarios over last 43 years

Namibia - Effect of scenario on household grass income - US$
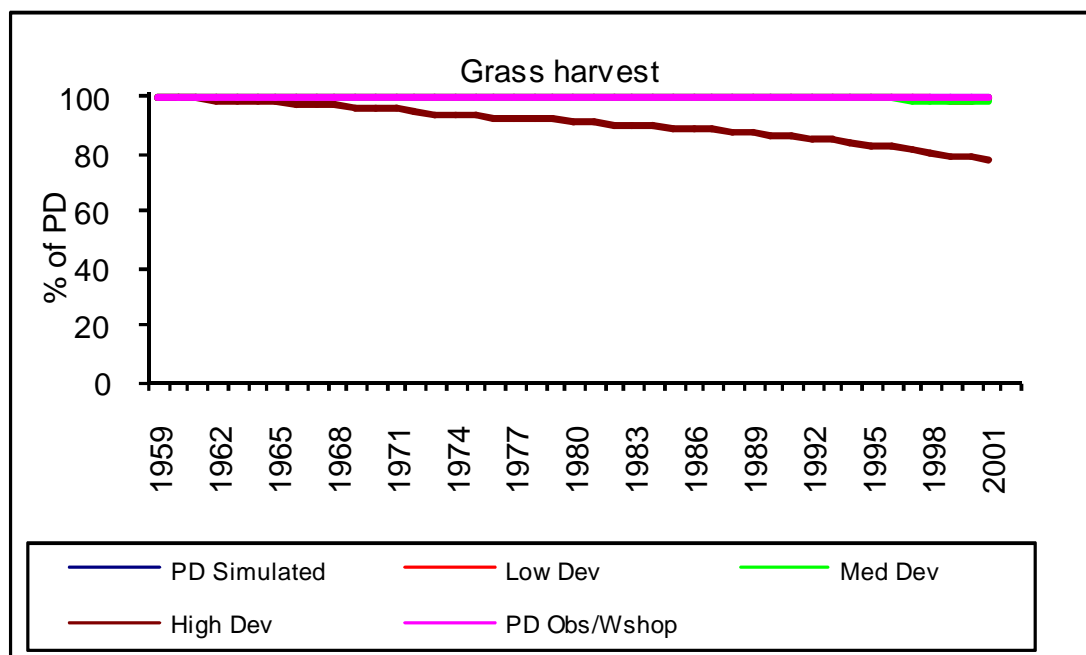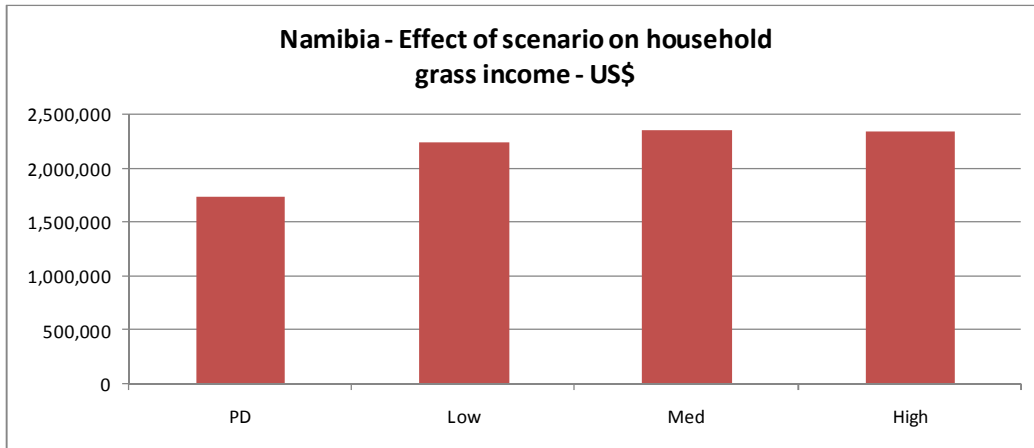
Aggregate short term effect of scenario on livelihoods from floodplain grass harvest in Namibian basin (US$/annum, where US$1.00 = N$8.16)

Namibia grass direct economic contribution 40 year NPV @ 4% (US$)
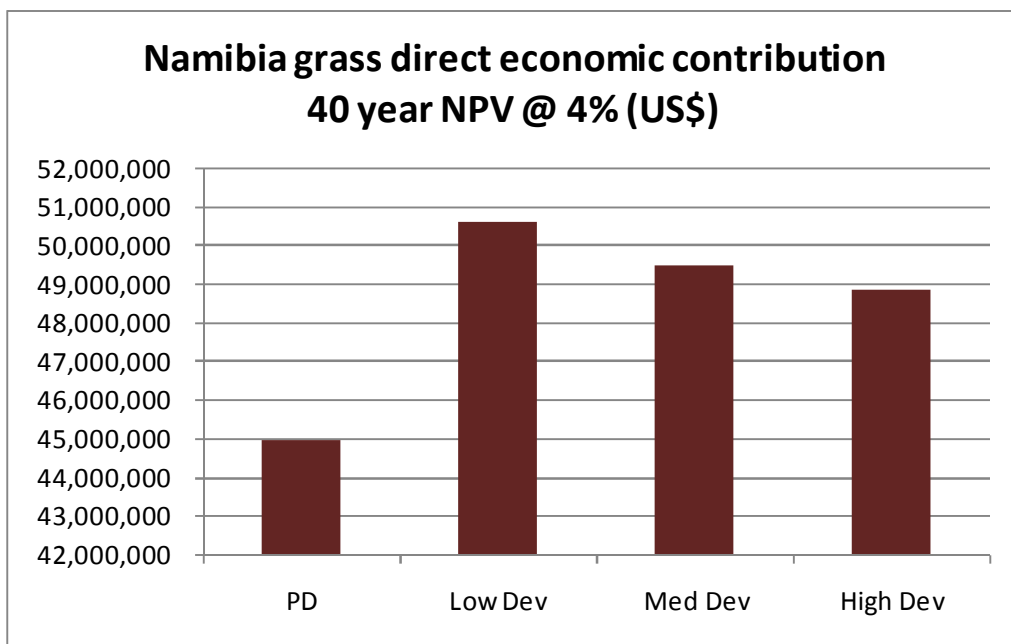
Aggregate long term effect of scenario on direct economic impact from floodplain grass harvest in Namibian basin (US$, 40 year NPV @ 8%, where US$1.00 = N$8.16)

Indicator 4 - Floodplain gardens

KAPAKO - IUA 8 - Study site 4

Present day gardens occupy half of lower floodplain. With decreasing floodplain area gardens reduce proportionally. With increasing flood plain area, garden increase tapers off due to capacity /demand / priority.
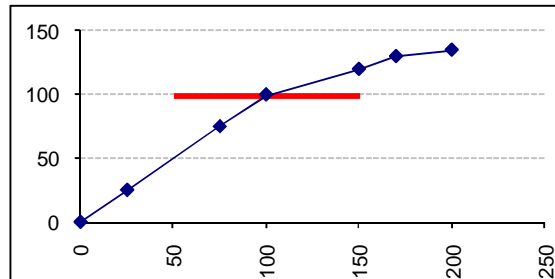
Floodplain gardens response to lower floodplain extent (% of present day)
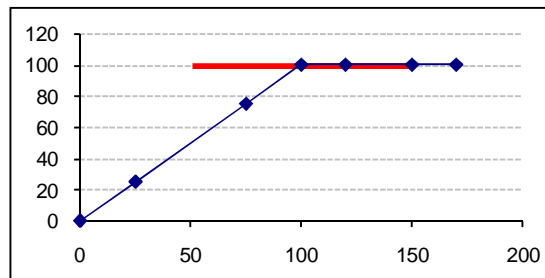
Floodplain gardens harvest response to middle floodplain extent (% of present day)
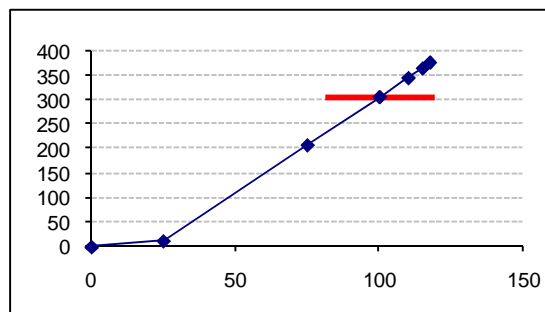
Household net income response to floodplain gardens (N$ per household per annum)
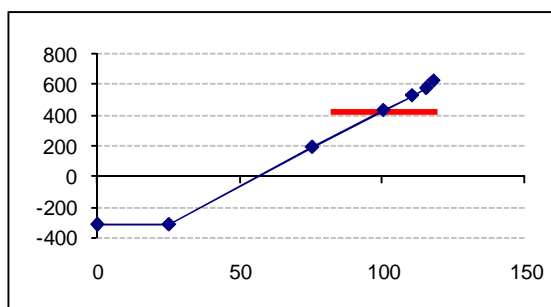
Economic impact response to floodplain gardens (N$ per household per annum)
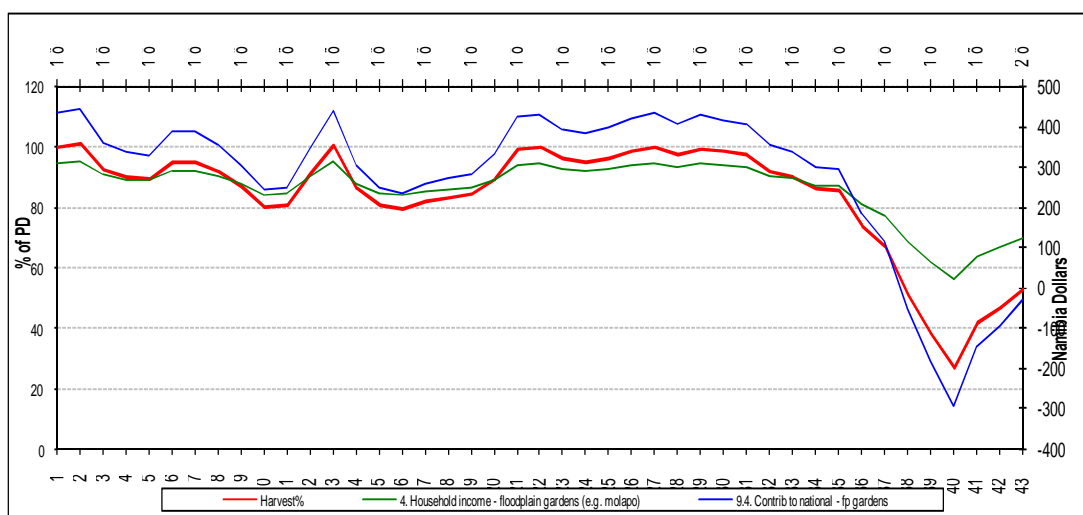
Changes in floodplain gardens livelihood and total economic impact in last 43 years
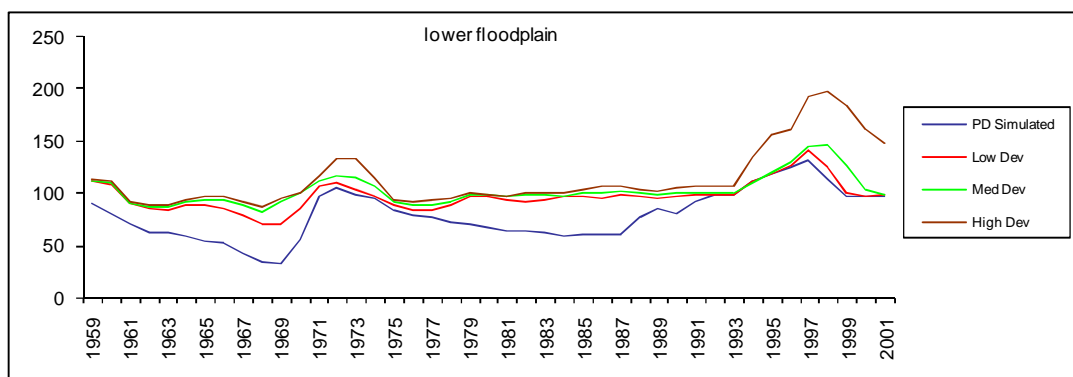
Simulated floodplain gardens response to scenarios in lower floodplain over last 43 years
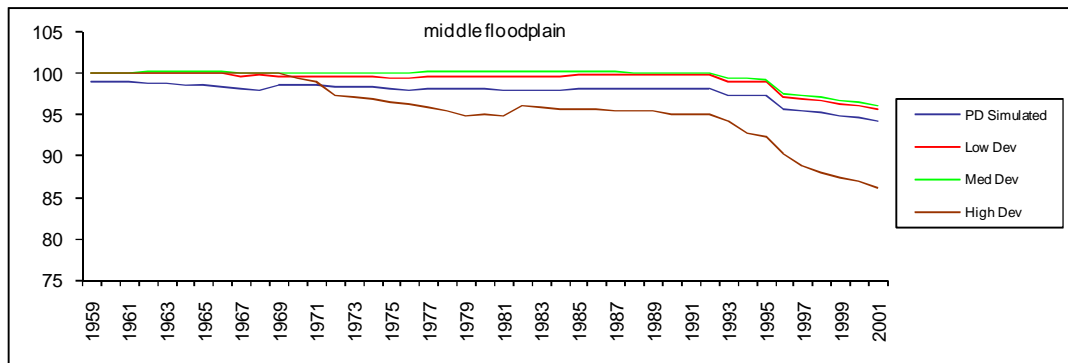
Simulated floodplain gardens response to scenarios in middle floodplain over last 43 years
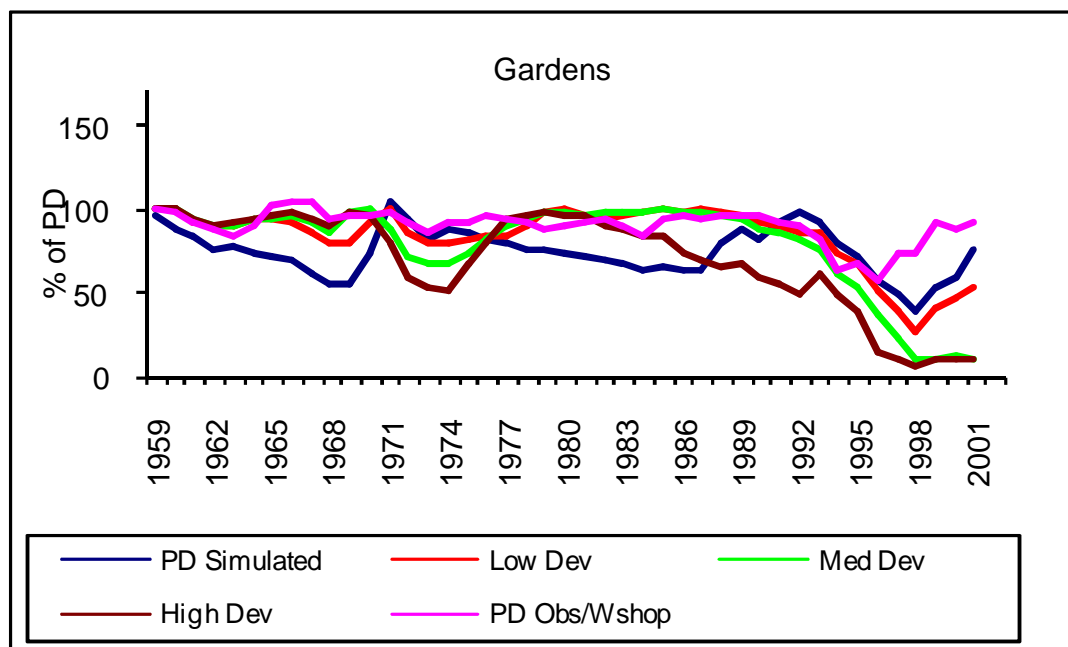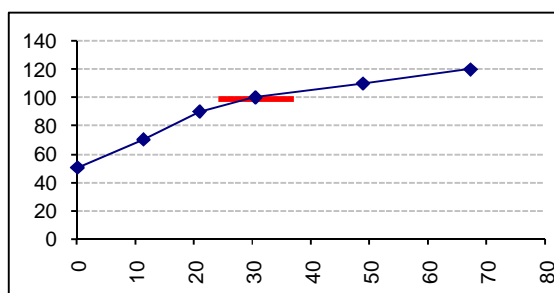

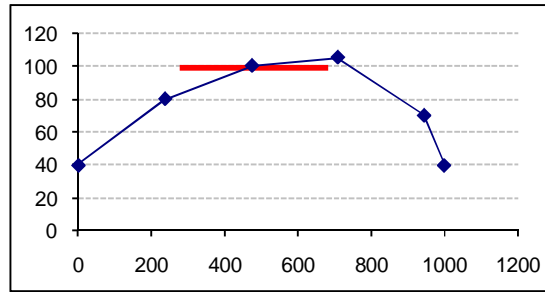Simulated general floodplain gardens response to scenarios over last 43 years

Indicator 5 - Floodplain grazing

KAPAKO - IUA 8 - Study site 4
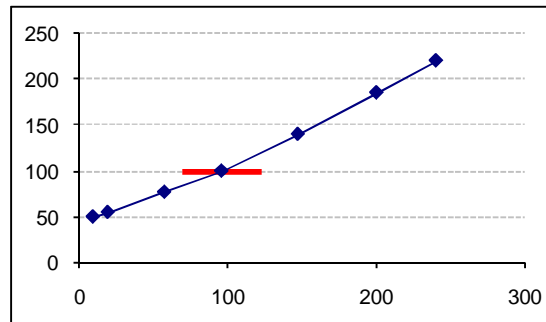
Present day floodplain grazing is on lower middle and upper floodplain. Present day grazing is above carrying capacity. Decreasing area could result in drop in stock numbers. Increasing area may result in increased stock numbers.
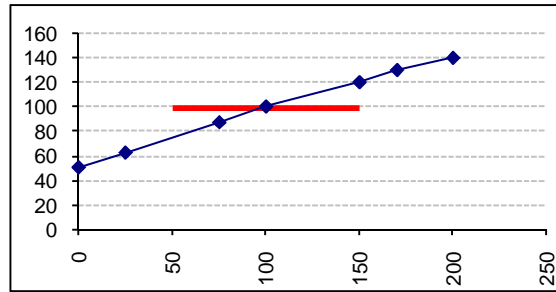
Floodplain grazing response to lower floodplain extent (% of present day)
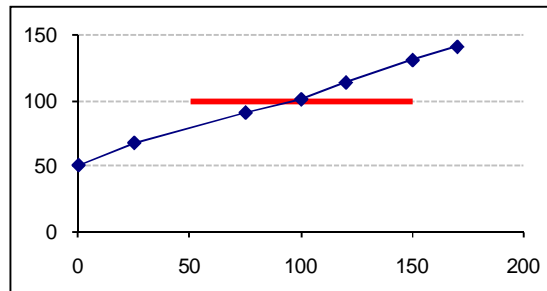
Floodplain gardens harvest response to middle floodplain extent (% of present day)
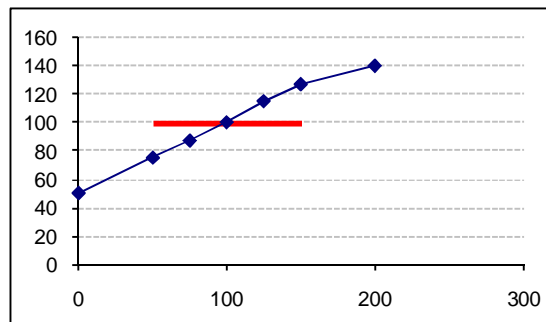
Floodplain gardens harvest response to upper floodplain extent (% of present day)
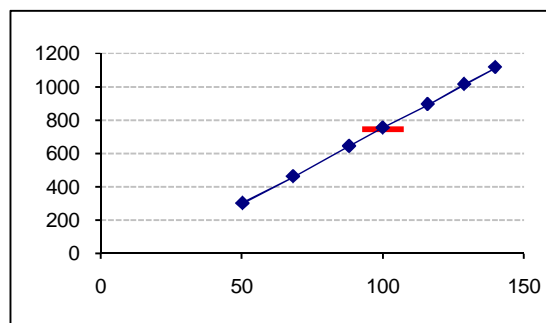
Household net income response to floodplain grazing (N$ per household per annum)
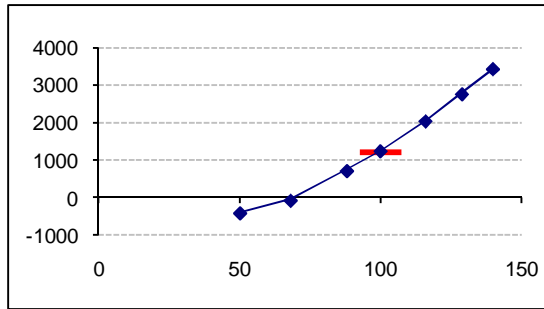
Economic impact response to floodplain grazing (N$ per household per annum)
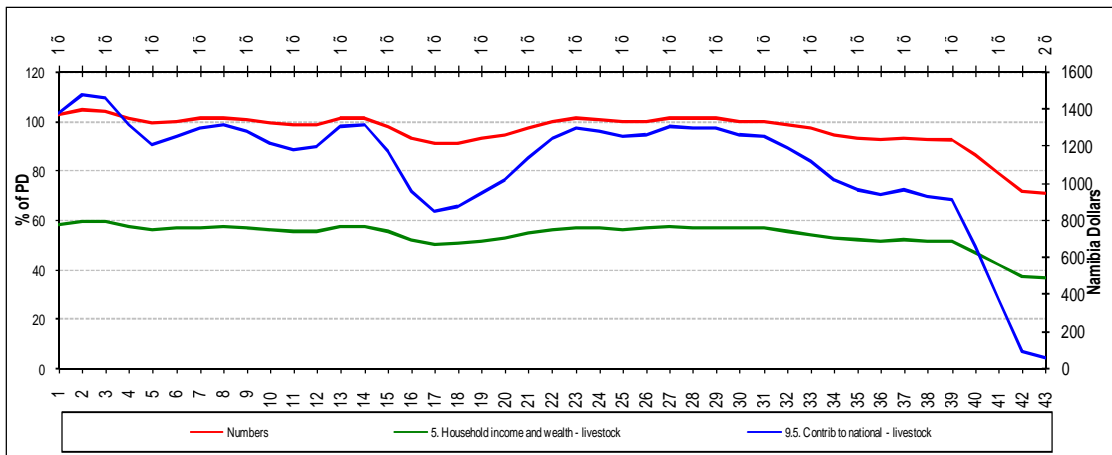
Changes in floodplain grazing, livelihood, and total economic impact in last 43 years
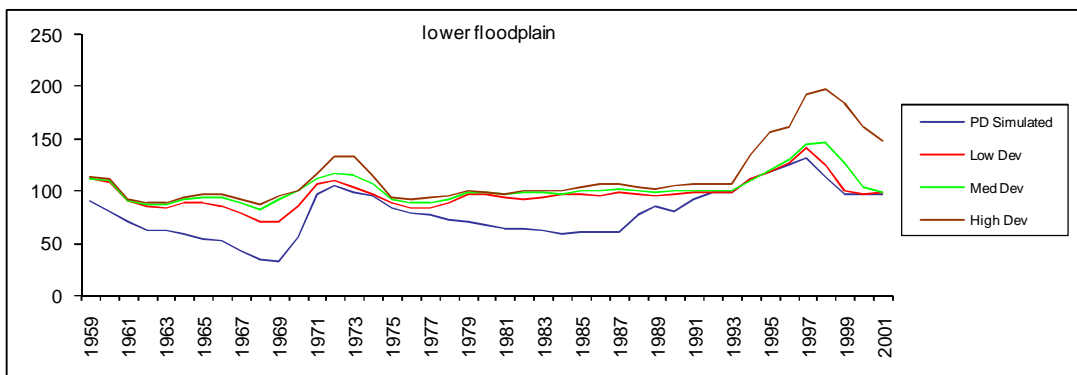
Simulated floodplain grazing response to scenarios in lower floodplain over last 43 years
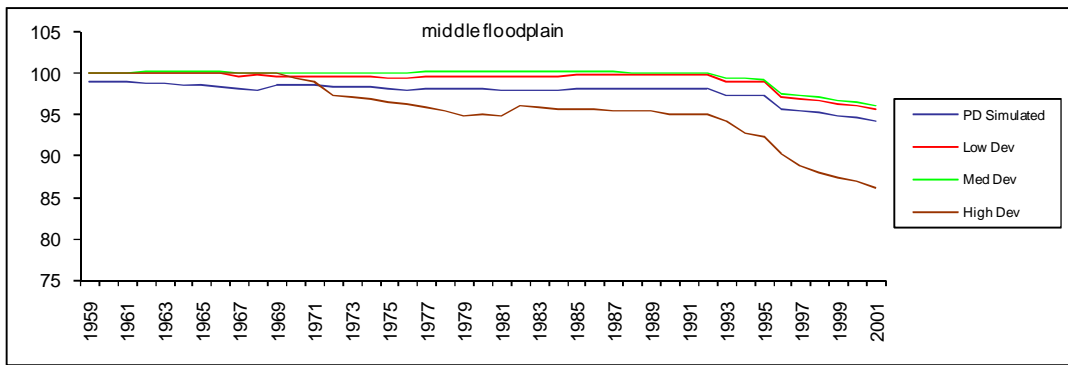
Simulated floodplain grazing response to scenarios in middle floodplain over last 43 years
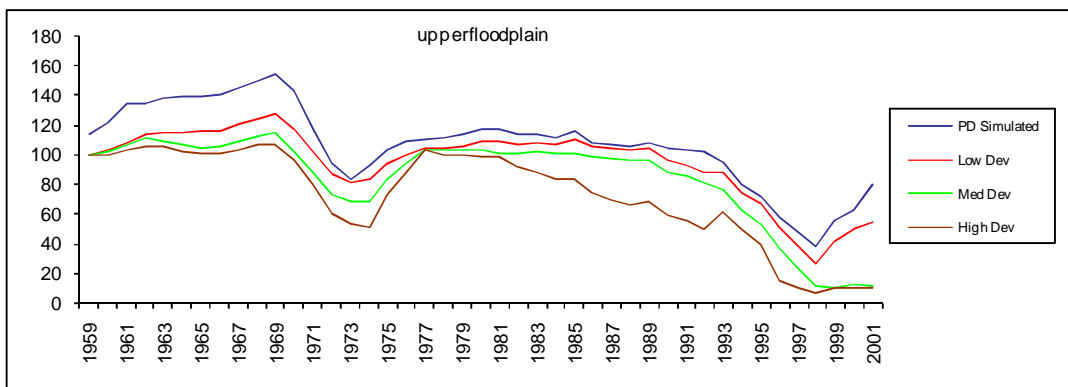
Simulated floodplain grazing response to scenarios in upper floodplain over last 43 years

Livestock output
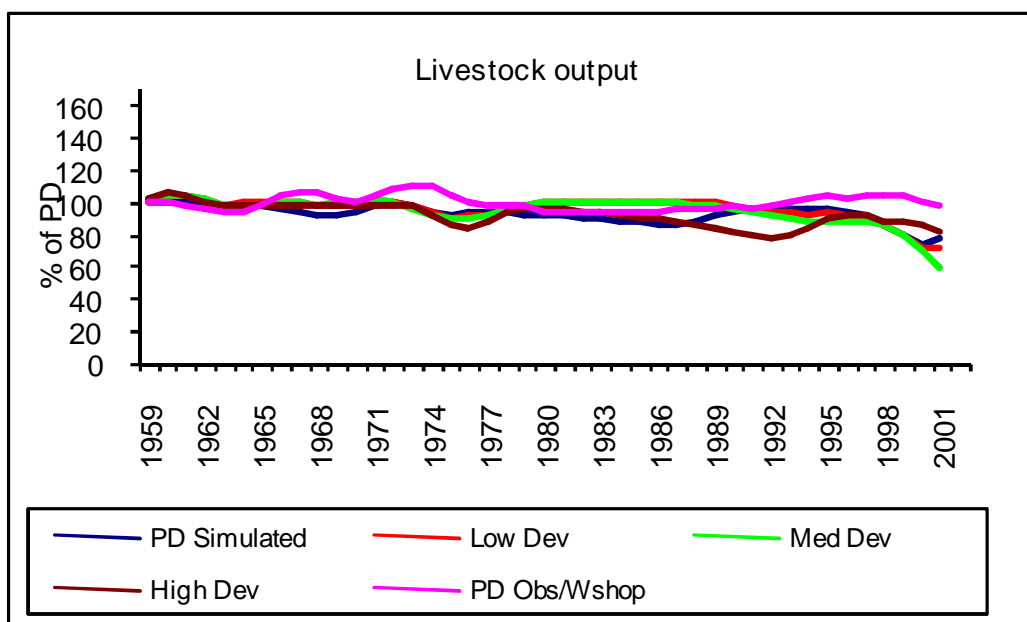
Simulated general floodplain grazing response to scenarios over last 43 years

Indicator 6 - Tourism

KAPAKO - IUA 8 - Study site 4

Dry season channel flow only affects tourism numbers at very low levels. Flood type is measured by volume (in this example). Response is estimated based on empirical survey results. Enhanced wildlife mainly birds increases tourism numbers but decreasing wildlife has a relatively small effect on the general demand. Demand in this area is not primarily driven by wildlife.

Tourist numbers response to dry season low flow (% of present day)

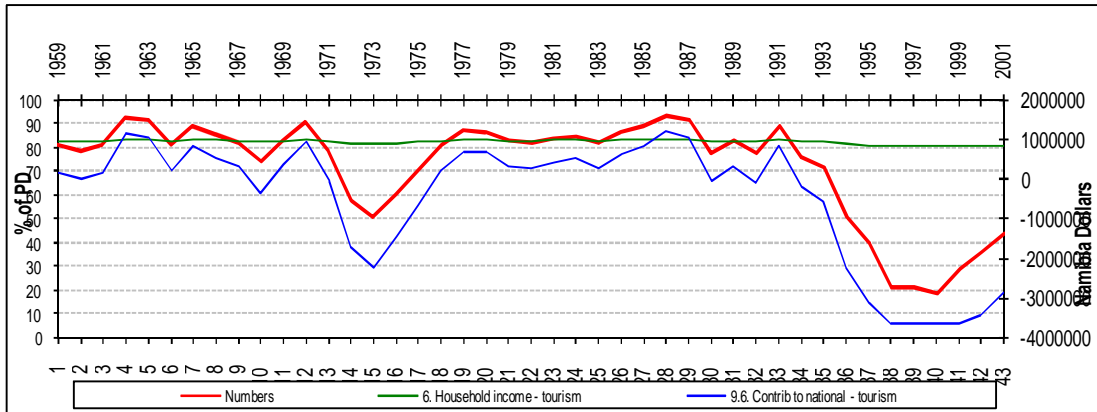Tourist numbers response to flood type (% of present day)

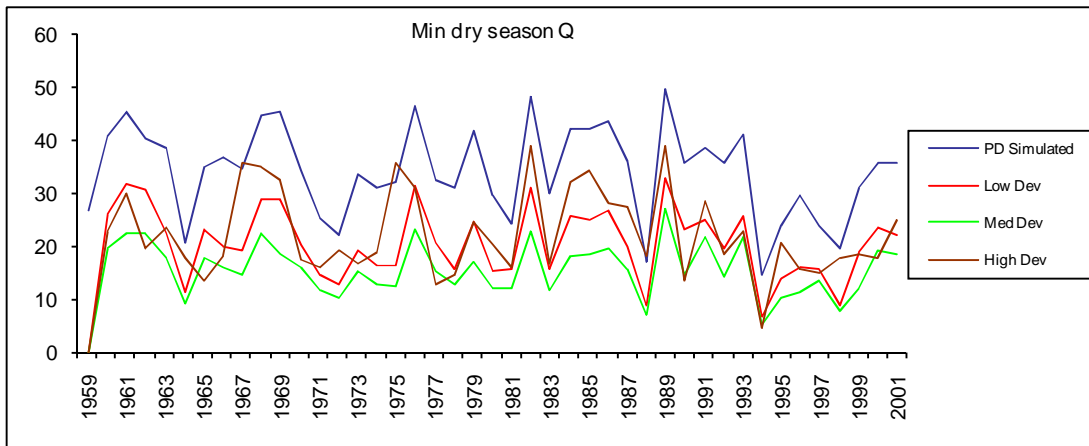Tourist numbers response to wildlife abundance (% of present day)

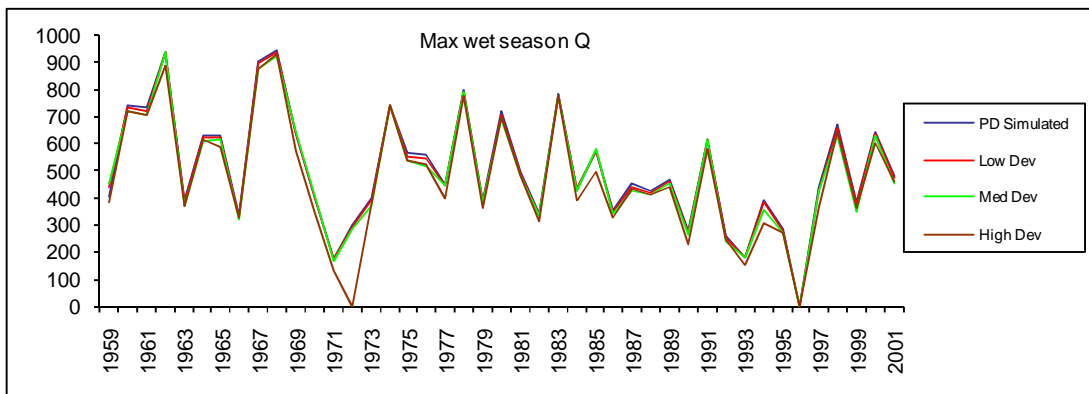Household net income response to tourist numbers (N$ per household per annum)

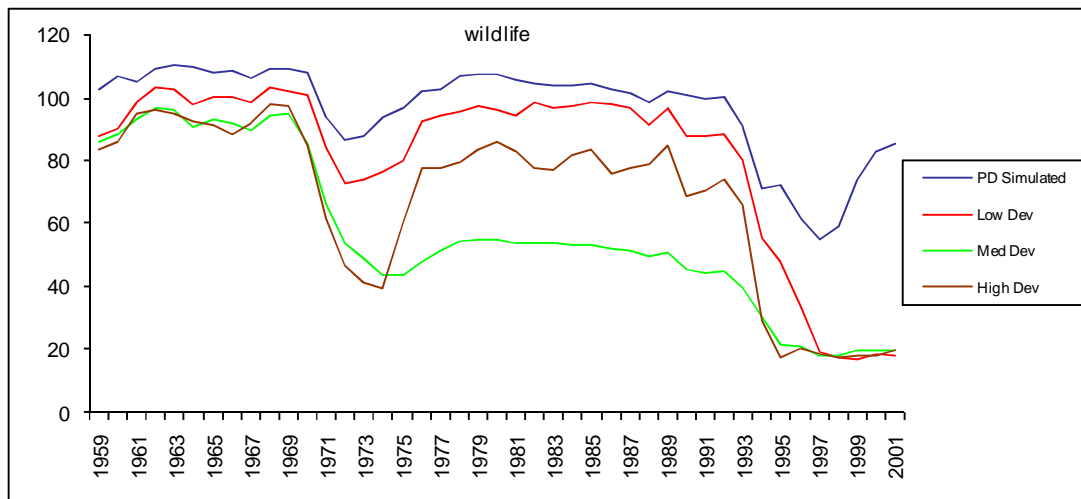Economic impact response to tourist numbers (N$ per household per annum)

Changes in tourist numbers, livelihood, and total economic impact on in last 43 years
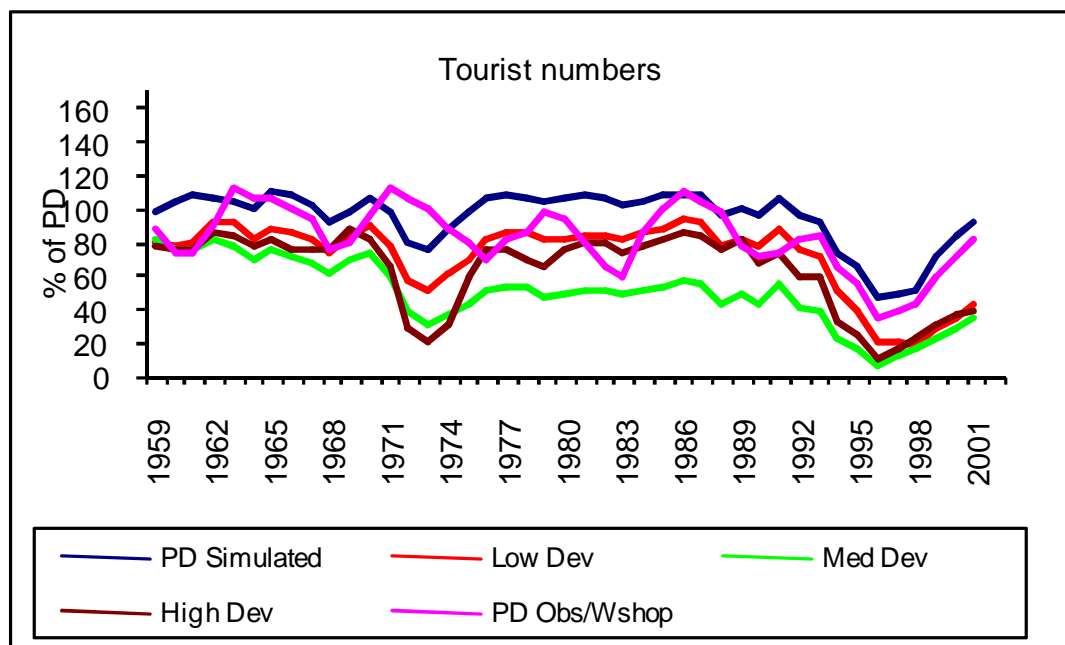

Simulated tourist numbers response to scenarios in case of dry season minimal flow over last 43 years

Simulated tourist numbers response to scenarios in case of flood type over last 43 years

Simulated tourist numbers response to scenarios in case of wildlife numbers over last 43 years
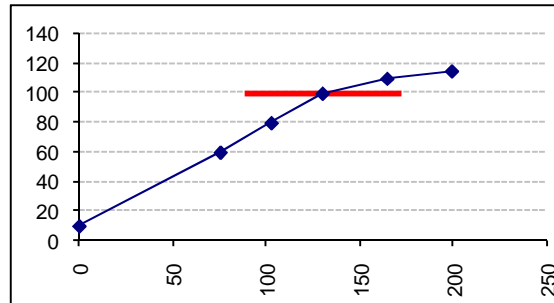

Simulated general tourist numbers response to scenarios over last 43 years
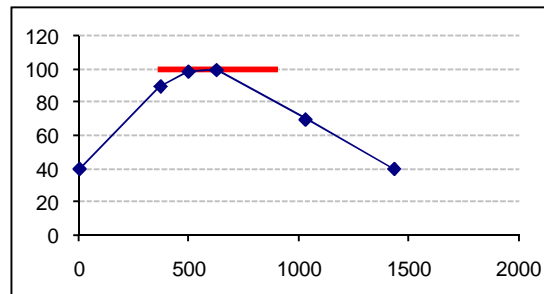
POPA - IUA 9 - Study site 5

Dry season channel flow only affects tourism numbers at very low levels. Flood type is measured by volume (in this example). Response is estimated based on empirical survey results. Enhanced wildlife mainly birds increases tourism numbers but
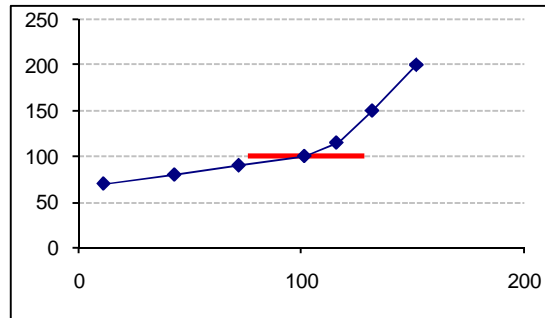
decreasing wildlife has a relatively small effect on the general demand. Demand in this area is not primarily driven by wildlife.
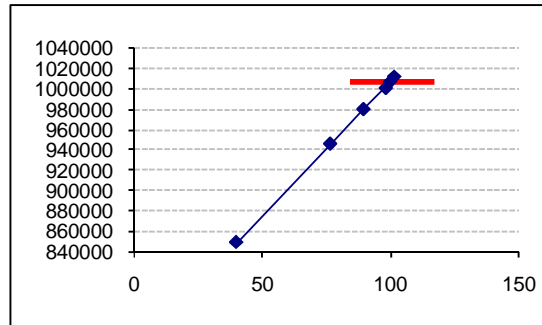

Tourist numbers response to dry season low flow (% of present day)
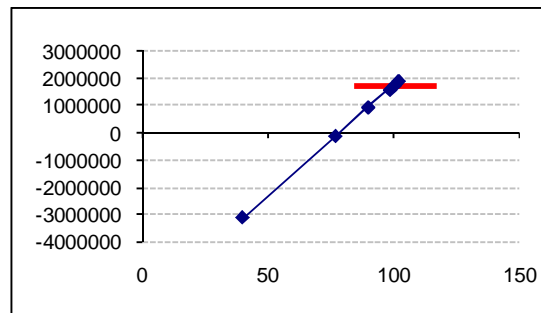

Tourist numbers response to flood type (% of present day)

Tourist numbers response to wildlife abundance (% of present day)

Household net income response to tourist numbers (N$ per household per annum)

Economic impact response to tourist numbers (N$ per household per annum)

Changes in tourist numbers, livelihood, and total economic impact on in last 43 years

Simulated tourist numbers response to scenarios in case of dry season minimal flow over last 43 years

Simulated tourist numbers response to scenarios in case of flood type over last 43 years

Simulated tourist numbers response to scenarios in case of wildlife numbers over last 43 years

Simulated general tourist numbers response to scenarios over last 43 years

Namibia – Effect of scenario on household tourism income – US$

Aggregate short term effect of scenario on livelihoods from tourism in Namibian basin (US$/annum, where US$1.00 = N$8.16)

Namibia tourism direct economic contribution 40 year NPV @ 4% (US$)
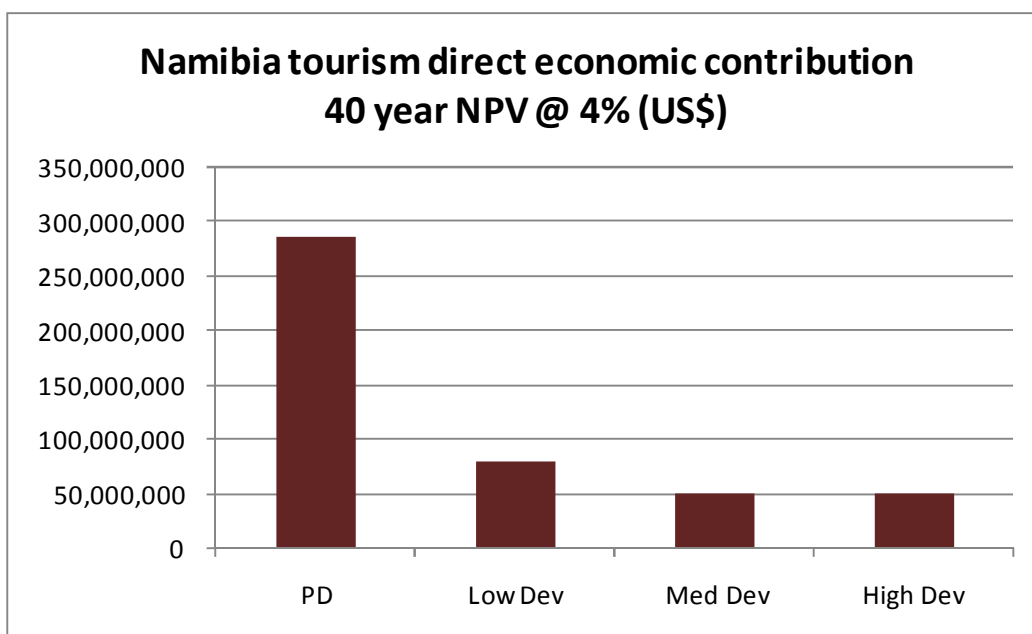
Aggregate long term effect of scenario on direct economic impact from tourism in Namibian basin (US$, 40 year NPV @ 8%, where US$1.00 = N$8.16)

Overall aggregate effects on livelihoods and the economy are presented below.

Namibia households direct economic contribution
40 year NPV @ 4% (US$)
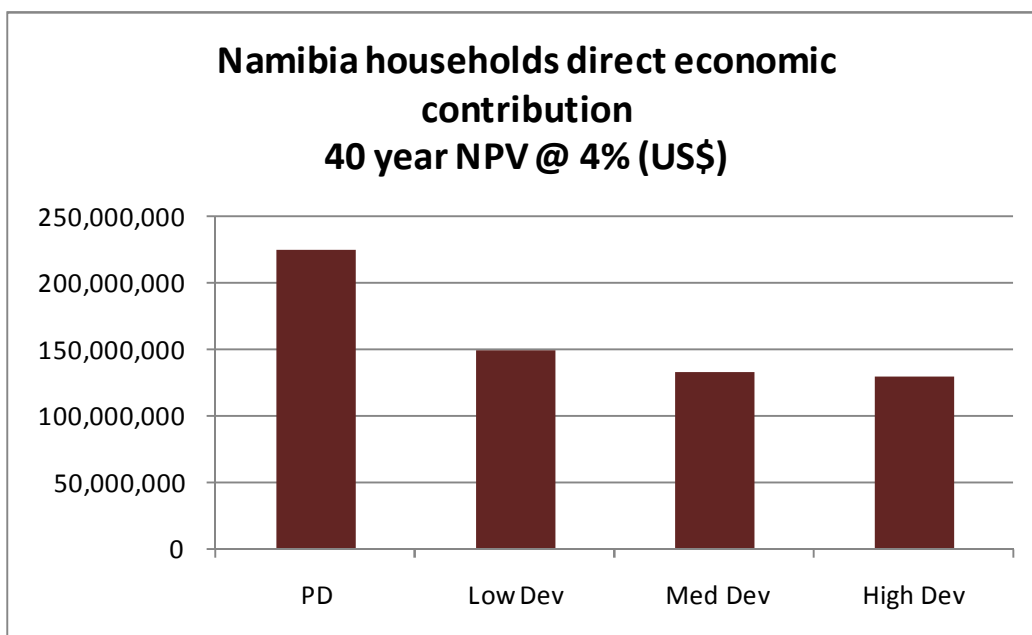
Aggregate long term effect of scenario on direct economic impact from household use of natural resource use in Namibian basin (US$, 40 year NPV @ 8%, where US$1.00 = N$8.16)

Namibia total direct economic contribution
40 year NPV @ 4% (US$)
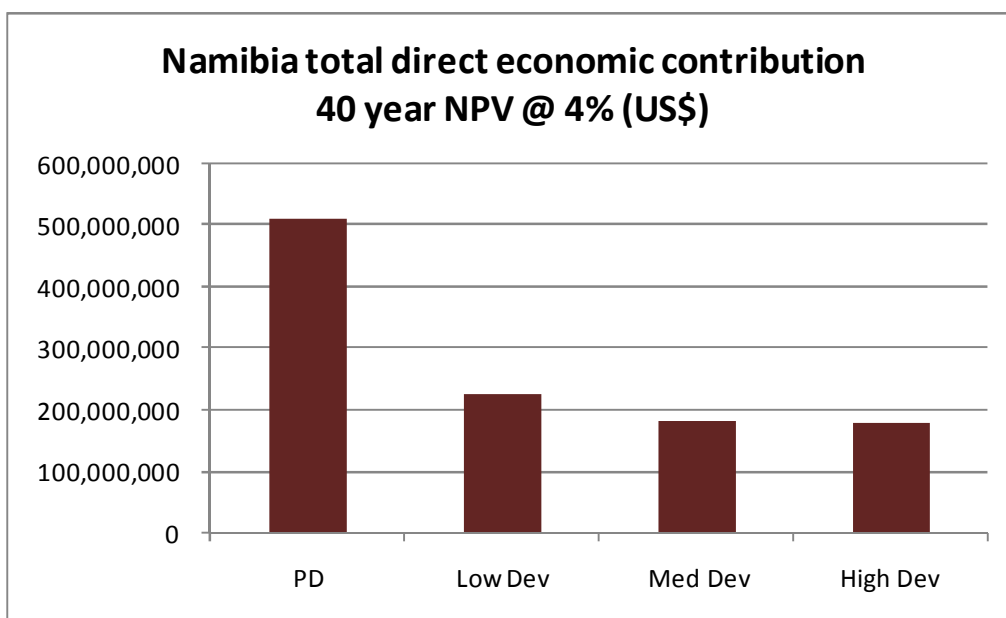
Aggregate long term effect of scenario on direct economic impact from all natural resource use in Namibian basin (US$, 40 year NPV @ 8%, where US$1.00 = N$8.16)

6   CONCLUSION

The EFA model has been successfully used to measure impacts of water change on the socio-economic environment in the Namibian part of the Okavango river basin. Many of the biophysical impacts of flow change on the river and the river ecosystem, as measured in the EFA model, translate into impacts on the livelihoods and economic welfare of the basin's people and economies. The biophysical responses modeled are linked to changes in abundance and availability of natural resource products used in the basin. These abundance responses, when applied to enterprise models, measure change in private net incomes (livelihoods) and economic national income (economic contribution).

Both livelihoods and national income are predicted to decline in the water use development scenarios. Livelihoods derived from river/wetland resources may decline in the long term by some 50%. The economic national income contribution may decline in the long term by up to about 70%. Short term impacts may be even more devastating.

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APPENDIX A: STAKEHOLDERS PARTICIPATION REPORT

EFA-Stakeholders Participation information in Kapako and Popa

D. Wamunyima

The stakeholder dialogue of the EFA was introduces in two sites in the Namibia side of the Okavango River Basin, (Kapako and Popa) as a unique participatory mechanisms enabling direct interaction between female and male participants of Chefs, local senior headman, village development committees, constituency development committee, extension officer, farmers, fisherman and basin residents at large on specific topics.

With the increasing recognition of the essential role played by major groups as custodian /users of the natural resources, meetings were conducted using the focus group discussion, and this was a participatory approach, continued to be developed, aimed at stimulating more productive dialogue and inspiring collaborative efforts among major resource user groups, local authorities as land custodian an the government system, building on lessons learned from the past traditional practices

During the focus group discussion the basin resident mentioned that, the flooding starts when the rising river and channel waters push out over flat surrounding ground and the biggest floodplains form in years when river levels are highest.

The most important feature of the flooded areas is that they are rich in nutrients. The floodplains also offer the young fish refuge from larger, predatory species and greatest survival of young fish and overall increase in fish population occurs in years when water levels are high and flooding lasts longest.

Local people have recognised the quality of water and fish recourses is decreasing in the Okavango River. Fish remain the significant feature in the lives of people at Kapako, who fish for food or earn incomes by selling their catches or providing trips for tourists. Fish stock in the floodplains is estimated to be four times higher than in the main channel.

The environmental flow analysis dialogues helped to promote meaningful stakeholders participation. The dialogues emerged as a significant component of the official meeting

The dialogues emerged as a significant component of the official meetings, and grew to become accepted as part of the process, rather than as an ancillary event taking place on the margins of negotiations.

The preparation for the collection of EFA data was itself a stakeholder participation process, involving a steering group of organizing partners from each major group. The content of the dialogue was determined in consultation with the EFA consultant and the organizing partners facilitated by the delineation process.

The organizing partners engaged in consultations with their major group to draft a 'dialogue starter paper' (a position questioner paper) and determine who would speak for the group during the dialogue. The dialogue papers were released as part of the official documentation in languages without editing the content. The Chair's Summary of the stakeholder participation segments reflected the areas of discussion covered during the dialogues and highlighted recommendations made by the major groups. Chair's summaries were included in the official report of each target sites are as below.

Site I: Kapako
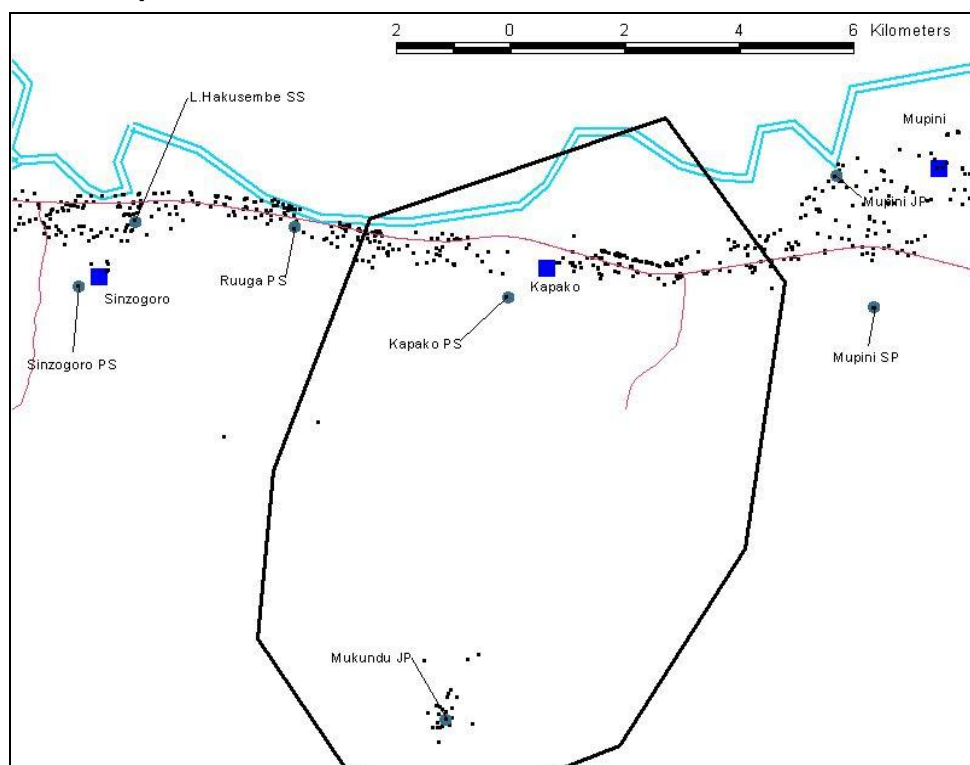
Site 2: Popa
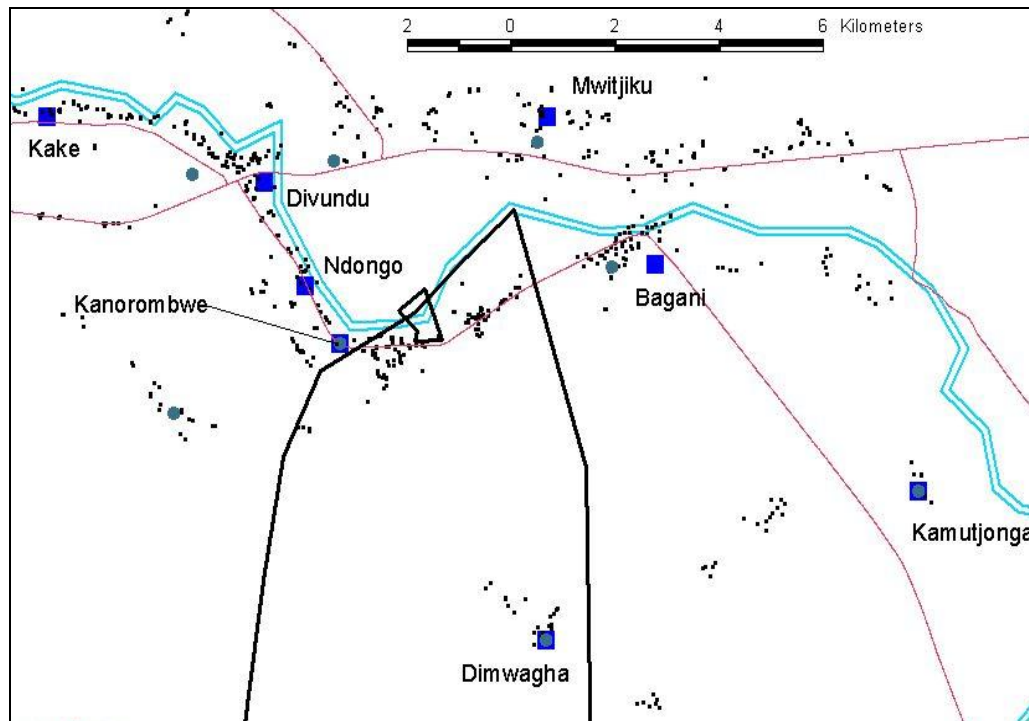
The EFA succeeded in integrating major groups fully into the stakeholders participation process, continuing the tradition of the multi-stakeholder dialogue and going further to establish the presence of major groups in high-level roundtables, expert panels, and partnerships for sustainable development.

About 47% of households at Kapako catch fish, the number of households that catch fish into accounts each person consumes an average of 10-20 kilograms of fish per year.

September to December when the river is at its lowest and fish are concentrated is the peak months for fishing at Kapako.

The kinds of traps or gear used to catch fish are separated into traditional and modern methods.

The most used traditional gear are fish funnels, kraal traps, scoop baskets, push baskets, bows and arrows, set fish hooks and spears

Modern gear consists of line and hooks, wire mesh fykes, mosquito nets, and gill and seine nets.

The use of fish for recreational angling forms part of the tourism value associated with the river. Biophysical response curves for the angling species would feed into the tourism values for the river reducing them to a partial extent. Only a small part of tourism values is attributable to angling

The riverine landscape comprises of main Okavango river channel, floodplains with braided channels, fluvial terrace with alluvial deposits are flooded regularly

The increase in human population and clearing for crops and livestock has put more pressure on the natural resources along the main channel

The vegetation along the river bank is overgrazed and depleted, thus at Kapako the residents graze their livestock across the river on the Angolan floodplain

Physical changes in land use, land cover and population density within a rivers watersheds usually have an impact on the hydrology and water-quality of the river.

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Recommendations

It is important that the role of social science and technology in human affairs be more widely known and better understood, both by decision makers who help determine public policy and by the general public. The cooperative relationship existing between the scientific and technological community and the general public should be extended and deepened into a full partnership.

Improved communication and cooperation between the scientific and technological community and decision makers will facilitate greater use of scientific and technical information and knowledge in policies and programme implementation. Decision makers should create more favourable conditions for improving training and independent research in sustainable development

Existing multidisciplinary approaches will have to be strengthened and more interdisciplinary studies developed between the scientific and technological community and policy makers and with the general public to provide leadership and practical know-how to the concept of sustainable development.

The public should be assisted in communicating their sentiments to the scientific and technological community concerning how science and technology might be better managed to affect their lives in a beneficial way. By the same token, the independence of the scientific and technological community to investigate and publish without restriction and to exchange their findings freely must be assured.

The adoption and implementation of ethical principles and codes of practice for the scientific and technological community that are internationally accepted could enhance professionalism and may improve and hasten recognition of the value of its contributions to environment and development, recognizing the continuing evolution and uncertainty of scientific knowledge, e.g. the National development Action Plan (NDAC) for the Okavango River Basin