ECONOMIC VALUE OF THE ZAMBEZI BASIN WETLANDS

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IUCN Regional Office for Southern Africa

ZAMBEZI BASIN WETLANDS CONSERVATION AND RESOURCE UTILIZATION PROJECT

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by

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CONTENTS

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EXECUTIVE SUMMARY

This resource economics study forms part of the Zambezi Basin Wetlands Resource Conservation and Utilisation Project (ZBWCRUP) which was initiated by the IUCN. This report covers Phases I and II of the resource economics study, which is being conducted in two phases. The main aims of the study were:

- to assess and contribute to resource economics capacity, especially pertaining to wetlands valuation, in the region;
- to review wetlands valuation methodology;
- to assess the economic value of wetlands goods and services in four Zambezi Basin wetland areas, the existing disincentives for their sustainable use, and to provide recommendations for their future management;
- to assess the influence of existing policies on wetland resource conservation and use; and
- to provide an economic assesssment of current ZBWCRUP initiatives in the project areas.

Over 100 people were identified as working or interested in the field of resource economics in central-southern Africa. However, very few of the 70 relevant respondents to a survey claimed to have practical experience in wetlands valuation. About half of the regional respondents were originally trained in the biological, environmental and agricultural sciences and acquired resource economics training later through self-teaching, short courses and postgraduate degrees. Many of them reside outside of Africa.

Current initiatives to build capacity in the region focus on the provision of short courses at both universities and NGOs that target a wide range of students and middle management in the private and public sector. Very few universities offer degrees in resource economics at either the undergraduate or postgraduate level and most regional institutions lack the critical mass required to conduct resource economics research and training. More emphasis needs to be placed on developing postgraduate training in resource economics and on post creation in both academia and the public and NGO sectors. It is recommended that new capacity-building initiatives target more senior management officials in the private and public sectors. Resource economics centres should be strategically placed and developed, and networking among them should be encouraged and funded to become more active in information dissemination of research, policy inputs and regional collaboration, and database maintenance. Within this project, capacity building efforts have included introducing field project officers to the subject by means of reading material and discussions.

Methods used to value wetlands goods and services are the same as those used for most other types of natural resources. These methods can be divided into market-based, surrogate-market and simulated market approaches, or in the absence of data, a benefits transfer approach using comparable data from other areas can be used. Different methods are used to measure different types of value, i.e. consumptive and non-consumptive use values, e.g. from resource harvesting and tourism, indirect use values provided by ecosystem services, option or future use value, and non-use or existence value. Option and non-use value can only be measured using contingent valuation methods which involves a simulated market approach, whereas a number of methods can be applied to measure the other types of value, depending on the availability and quality of data. Not all methods are applicable in a developing country context, especially under systems of communal resource management, and several factors need to be taken into consideration when choosing and applying valuation methods. The values derived from these methods represent current annual values, and need to be converted to present value, which is the present value of the future stream of annual benefits over a number of years. Two factors play a critical role in estimating present values: the choice of discount rate, and the sustainability

of value generation from the wetland. The latter consideration dictates that considerable biological as well as human use information is needed to avoid over- or underestimation of wetland values.

Review of the existing information and household and focus group surveys was undertaken to identify the main wetlands goods and services in the four ZBWCRUP study areas, and to provide estimates of their value. The four study areas were:

- Barotse Floodplain in western Zambia
- Chobe-Caprivi wetlands in Namibia and Zambia
- Lower Shire wetlands in Malawi and Moçambique
- Zambezi Delta in Moçambique

The four study areas differ markedly in size and population density. Cattle densities are relatively similar across three of the study areas, but are thought to be virtually absent from the Delta. Nevertheless, ratios of cattle to people are very low in the Lower Shire, where crops were more predominant than in the other areas. A static model was used to produce estimates of annual financial and economic values yielded by the direct use of wetland resources. Both financial and economic values are important to consider in the context of management of resources in the Zambezi basin wetlands. The financial returns are those that govern household and investor behaviour, and an understanding of these values is important if incentives measures are to be put in place to encourage the sustainable use of resources. The economic values illustrate the value that the wetlands add to the national economy.

This study suggests that traditional agriculture - livestock and/or cropping - plays a dominant role in the household economy in all four of the wetland areas. Not all agricultural value is attributable to the wetlands, however, but part of the value is also derived from upland systems within and surrounding the wetland habitats. Natural resources harvested from the wetlands, particularly fish, make a substantial contribution to household income.

The annual net financial income per household from livestock production ranges from US$31 in the Lower Shire to US$120 and US$422 in the Barotse and Caprivi wetlands, respectively. Total economic value of livestock grazing in the wetlands ranges from US$1.8 million in Caprivi to US$3.9 million in the Barotse wetlands. According to our estimates, subsistence cropping yields net financial incomes per household of between US$89 in Barotse to US$295 in the Lower Shire. Cropping yields high economic benefits in the Lower Shire (US$13 million) and Delta (US$4.8 million) wetlands, but incurs economic costs in the Barotse and Caprivi wetlands. Fields were largest, and yields were particularly low, in the latter wetland. Irrigated agricultural schemes have been established in all four of the wetland areas, mainly for the production of sugar and rice for commercial and export purposes. Limited data available suggest that they yield high gross financial returns in comparison to subsistence agriculture. The economic value of these schemes is likely to be low, however. It is important to realise that only part of the value of crops can be attributed to wetlands, being the extra production gained due to fertile floodplain soils. The total value of floodplain agriculture represents the value of *conversion*, rather than *conservation*, of the wetlands.

A number of natural resources are harvested within the wetlands, and these are similar throughout the four study areas, except that in the Delta marine, estuarine and mangrove resources are also utilised. All the wetland communties make use of fish, wild animlas, palms, grasses, reeds, papyrus and food plants. Communities in the Delta also harvest mangrove wood. The quantities of different types of resources harvested by households are also relatively similar from wetland to wetland, reflecting the similar lifestyles and needs of the communities. In the Delta, harvests of reeds and papyrus appear to be reduced to some extent due to the greater availability of an alternative construction material - palm wood.

Fish are the most important natural resource in all the wetlands, and contribute a significant proportion of household income. Fisheries have declined in all four areas, and are probably most severely impacted in the Lower Shire, where average annual household income from fishing, including non-fishing households, is lowest (US$42/hh). The Delta fishery, which yields the second-lowest level of household income (US$96/hh), has probably been significantly impacted by the changed hydrological regime since the closure of the Kariba and Cahora Bassa dams. Households in the Barotse and Caprivi wetlands gain US$174 and $224 per year on average. The total economic contribution of fisheries is related to overall wetland size. Fisheries in the different wetland areas contribute between US$0.7 and US$8.2 million to national economies annually.

Harvest of wild animal resources was generally found to be low, with survey respondents usually referring to small animals such as birds and rodents. These resources are severely depleted in all of the wetlands. Values were somewhat higher in Caprivi, where game animals are still replenished by the wetlands' connection with the Chobe National Park. Wild animals in the wetlands contribute between US$0.2 and US$48 per household per year, and between US$5800 and US$215 000 per year to national economies in terms of subsistence use. This use is likely to have been under-reported, however, due to the illegality of most of these activities.

Plant resources, including the value added through production of mats, baskets, etc, yield a financial net income of between US$19 and US$129 per household per year, and have a total economic value of between US$436 000 and US$2.8 million.

The total financial and economic net value of natural resource use in the four wetland areas, as a function of area, is strongly correlated with population density, which means that total use value increases as population density increases, due to greater use. However, values per person decline as population density increases. In general there were no consistent trends between household wealth status and demand for resources. Different values are realised by different user groups and genders. In all four study areas, different resources tended to be harvested by either men or women, and gender roles are fairly strongly defined. These issues do not affect the value of wetland resources *per se,* in that the community benefits to the same degree, irrespective of how labour is allocated within the household. However, as evidenced by their predominance at meetings during this study, men tend to make decisions which affect the resources collected by women as well as those they harvest themselves, and this has implications for the sustainability, and hence long term economic value, of many resources whose degree of scarcity they may not fully appreciate. While it may not be appropriate to interfere with the cultural norms of these societies by imposing western values on them, it is important that these factors are taken into account during policy formation and implementation, and in resource management and education programmes.

Tourism value exists to some extent in all four study areas, but was only considered quantitatively for the Chobe-Caprivi, where, of the annual net economic value generated by lodges, at least US$3.6/ha can be attributed to the wetland itself. Tourism value is currently small in the other areas, although there is limited potential for tourism in these areas.

Wetlands in the Zambezi Basin have many different ecosystem functions, which provide indirect use value in the form of support to a wide range of economic activities. Ecosystem functions valued in this study include flood attenuation, groundwater recharge and water supply, sediment retention, water purification and carbon sequestration. Other important wetland ecosystem functions that were not valued in this study include shoreline protection, wildlife habitat, breeding and nursery functions, nutrient trapping, micro-climate regulation. The estimated net present value of the valued ecosystem functions ranges from US$22 million in the Chobe-Caprivi to US$80 million in the Delta, with the value of carbon sequestration dominating in all wetlands except the Lower Shire, where the values of water purification and groundwater supply are dominant. The estimated indirect use values are generally of the same order of magnitude as the NPVs reported for direct uses. No accurate data are available that enable an assessment of whether current ecosystem functions are being utilised at sustainable levels or not, although some qualitative data exist that indicate water purification functions are being exceeded in the Lower Shire while groundwater supply functions are largely untapped in the Delta. The limitations on data in this study resulted in the use of simplistic methods that inherently tend to provide low-end estimates, and estimates of NPV should be considered as minimum.

The non-use or existence value of wetland biodiversity in Zambia was measured employing the Contingent Valuation Method (CVM), using a questionnaire survey. The main aim of the survey was to ascertain Zambians' willingness to pay (WTP) for the conservation of biodiversity in the Barotse wetland. Due to low literacy, low income and unwillingness to consider hypothetical questions among rural households, the questionnaire was designed for urban Zambians defined by the national government as formally employed. The instrument thus captures the higher values of a relatively minority group, and produces a minimum estimate of non-use value. At least 80% of respondents stated that they would be willing to make a donation to a conservation agency in order to help them acquire sufficient funds to bid for wetland rights to prevent agricultural conversion and ensure conservation and wise use. The average WTP per respondent, as a once off payment, was US$35.06 towards conservation rights for all major Zambian wetlands, and an average offer of ZK18 921 US$8.90 was received for the Barotse wetlands. This translates to a total value, in present terms, of US$16.7 million for all Zambian wetlands and US$4.2 million for the Barotse wetlands. The non-use value estimated is a value for the conservation and wise use of wetlands, and not for exclusive protection. It also includes an element of option value since preferences for conservation often arise from the desire to conserve the resource for future potential uses. Such wise use management practices are currently promoted internationally by Wetlands International, IUCN and other major conservation agencies, and this study implies that such a policy does have a value to all people irrespective of use.

Various options exist for the future management of the wetlands, including maintaining the status quo, implementing wise use practices, delimiting protected areas, and commercial agricultural development. Using a dynamic ecological-economic model, it was shown that the current unsustainable use of resources in the wetlands will erode their value in future, as many resources are likely to be significantly depleted over the next twenty years. The current status of the wetlands has been caused by numerous economically-driven factors, such as poverty and weak tenure and management systems, underlain by rapidly increasing populations. Higher values are generated under a wise use management scenario, and a protected areas yield added benefits. The potential opportunity costs of commercial agricultural development are estimated, but the decision to implement such projects rests on their economic viability, which is likely to be low in most cases. The optimal management scenario of the wetlands is likely to include at least the first three management options.

Achieving the optimal sustainable use of the wetlands relies to a large extent on the existence of appropriate policy. Policies in all four countries have undergone changes over the last decade with significant potential impacts on wetlands management and utilisation. Macroeconomic and Sectoral policies have been updated to reflect new, market-driven strategies in line with national economic liberalisation and privatisation. Natural resource sector policies have been moving away from protection-focused regimes to ones which minimise state involvement in environmental conservation, promote sustainable utilisation and encourage private-sector and community-based management.

However, none of the four main countries associated with the four study areas have a single institution or policy concerned specifically with wetlands. Thus, multiple institutional and policy factors impact on wetland ecosystems which cross-cut different sectors of the economy. Sectoral policies that relate to specific activities which utilise wetlands goods and services, affect the integrity and status of wetlands or define mechanisms for wetlands management in these countries include environment, land, water, fisheries, forestry and wildlife, agriculture, urban settlement and industry. Typically, sectoral policies are overlapping in areas of concern, yet different sectors are governed by separate institutions, laws and management regimes. There is at best only partial coverage of wetlands issues in most sectoral policies in the four countries. This provides few direct incentives for sustainable utilisation and management and, in some cases, actually gives rise to perverse incentives which encourage wetlands conversion, depletion and degradation. In particular, agricultural policy is focused on expanding crop area and production and encourages land conversion in wetland areas. Agricultural legislation is also geared towards ensuring that land is used to its full productive potential rather than encouraging broad natural resource conservation. Fisheries policy also contains virtually no mention of wetlands ecosystems or their role in maintaining fisheries resources, and its primary aim of increasing catches may encourage wetlands over-exploitation and unsustainable utilisation. A key recommendation of this study is that wetlands policies be defined in the ZBWCRUP countries. These policies should define actions at regional, national and local levels, and should focus strongly on the use of economic instruments and incentives which will achieve the optimal sustainable use of wetlands.

The ZBWCRUP goal of sustainable wetlands utilisation and management is undoubtedly constrained by policy weaknesses and omissions in the Zambezi Basin countries which together fail to present adequate incentives for conservation. Furthermore, regional initiatives on wetlands management, including the Zambezi Action Plan and the various international agreements and conventions touching on wetlands issues, are focused more on assessment and planning than on-the-ground implementation. This situation needs urgent attention if the future utilisation of the Zambezi wetlands is going to be managed sustainably.

Finally, this study provides a brief economic perspective on the ZBWCRUP wetland management initiatives being carried out in the four study areas by the field project officers. Project activities are geared at improving (i) community well-being, (ii) awareness and (iii) training, as well as (iv) inventory and monitoring of resources and (v) resource management. Most of these actions have implications for natural resource conservation and utilization. Activities have tended to concentrate on community well-being. This is essential in order to meet conservation goals, but it is also important to realise that reducing peoples 'needs' does not necessarily change their 'wants'. The latter problem is better addressed through activities which increase awareness. Thus the first two types of activities are potentially far more effective if they go hand-in-hand. Information on resource availability and use is also essential for establishing and influencing sustainable use patterns, but there has been relatively little activity in this area. Most management initiatives have been implemented only relatively recently. These include projects to reduce pressure on resources through appropriate technology in Chobe-Caprivi, to reduce human-wildlife conflicts in Lower Shire and to explore under-exploited resources and restore mangroves in the Delta. The introduced improved technology for wood burning stoves in the Chobe-Caprivi has the potential to reduce fuelwood demand without having a negative cultural effect. Although not actually using a wetland resource, such technology could improve standards of living and reduce demand for other plants used for fuel in wetland areas. Wildlife incurs costs on wetland communities, and initiatives that either reduce these or provide benefits from the same animals would increase wetland benefits to communities as well as improving attitudes towards conservation. Neither the Lower Shire crocodile management plan, nor the Zambezi Delta mangrove restoration project, are likely to generate positive financial returns,but they could well be economically efficient, if changes in all economic values are taken into account. Decisions on whether to proceed with these projects, or not, should be based on the broader economic criteria. Initiatives to explore new or under-utilised resources have potential to yield new and sustainable sources of income, but it is imperative that both the supply and demand sides of the resource are well researched. However, this type of research is long-term and outside the potential scope of this project. Management initiatives in the study areas also include institutional reforms such as the establishment of local management committees in Barotseland and improving the security of land tenure in the Delta. While the latter is appropriate in the Delta where traditional communal management systems have been eroded, the former acts to reinforce and ensure the sustainability of traditional systems of management where these still have some influence. In general, these initiatives need a more co-ordinated and focussed approach which addresses common property regimes, alleviation of pressure on resources, education, management and training in that order of priority.

SUMÁRIO

Este estudo dos recursos económicos faz parte do projecto de conservação e utilização dos recursos das terras húmidas da bacia do Zambeze (ZBWCRUP) que foi iniciado pelo IUCN. Este relatório engloba as fases I e II do estudo de recursos económicos que esta sendo conduzido em duas fases. Os objectivos principais do estudo foram:

- Avaliar e contribuir para a capacidade economica dos recursos naturais no que diz respeito à protecção das terras húmidas (pantanais) da região;
- Para rever a metodologia da avaliação das terras húmidas;
- Para determinar o valor económico dos produtos provenientes das terras húmidas e os benefícios nas quatro áreas das terras húmidas da bacia do Zambeze, os obstáculos existentes para o seu uso equilibrado e sustentável e para fornecer recomendações para a sua futura administração;
- Para avaliar a influência das directivas existentes para a conservação e uso dos recursos naturais;
- Para fornecer uma avaliação económica das iniciativas actuais da ZBWCRUP nas áreas do projecto.

Mais de 100 pessoas foram identificadas como trabalhando ou estando, interessadas na área dos recursos económicos na Africa Central e Meridional. Contudo, um pequeno número dos 70 relevantes respondentes ao levantamento, reivindicaram ter experiencia prática na avaliação das terras húmidas. Cerca de metade dos respondentes da região foi, originalmente treinada em ciências biológicas, ambientais e agrícolas e adquiriu o treino de recursos económicos mais tarde estudando por si própria, frequentando cursos rápidos, de pouca duração ou fazendo posgraduação. Muitas destas pessoas vivem fora do continente Africano.

As iniciativas actuais para desenvolver a capacidade na região, está centrada na provisão de cursos de pouca duração nas universidades e nos sectores de Organizoções Não Governentais (NGO's) que etem em vista, um grande número de estudantes e a gerência média no sector privado e público. Muito poucas universidades oferecem cursos em recursos económicos quer para os estudantes universitários quer para os formados. A maioria das instituições regionais carece de estudo critico necessário para conduzir a pesquisa e o treino dos recursos económicos. Mais enfase necessita ser colocada em desenvolver o treinoem recursos económicos, apos a licenciatura e na criação de postos no sector academico e público e em sectores do NGO. Recommenda-se que as novas iniciativas de desenvolvimento deverão ter como alvo funcionarios mais experientes, a nivel de gerencia nos sectores público e privado. Os centros de recursos económicos devem ser estrategicamente situados e desenvolvidos e o intercambio entre eles deveria ser incentivado é financiado, para tornar-se mais activo na disseminação dos resultados da pesquisa, da participação nas orientações e da colaboração regional e na manutenção e actualização do registo de dados. Neste projecto numa tentativa de formar e ajudar os funcionarios foram organizadas sessões de discussão e material de leitura foi distribuido.

Os metodos usados para avaliar os benefcios e vantagens das terras húmidas são os mesmos usados para a maioria de outros tipos de recursos naturais. Estes metodos podem ser divididos em mercado de base, mercado substituto[1] e mercado simulado[2], ou na ausencia de dados, podes ser usada uma comparação a patir de dados recohildes em outras áreas. Diferentes metodos estão a ser usados para fazer diferentes tipos de avaliação consumiveis a nao-consumiveis - por exemplo: rendimentos de colheites, e Turismo, lucros indirecto furnecidões pelo servico do ecosistema, apeções or valor no futuro e o valor do non-use de existencia. “Opcão” e “non-use value” so poder ser calculados usando o metode de avaliação contingetes que envolve uma “simulated market approach” au posso que (enquanh que) um mimero variado de metodes pode ser applicado para fazer outros tipos de avaliação depenedo ser aplicaaaado para fazer outras tipos de avaliação dependo da disponsibilidade e da qualidade de dados. Nem todos os metodes são aplicaveis no contexto do pais em vias de dezenvolvimento especialmente debaixo de uma administração comunal de recursso. Varios factores devem ser tomados em conzideração quando da escola e aplicação do metodes de avaliação. Os valores derivades destes metodes representam or valores anuais actuais e tem de ser convertidos ao seu presente valor que e o valor dos futuros beneficios num determinado número de anos. Dois factores exercem um papel critico no calculo dos valores existentes: a escolha da taxa de desconto e a sustentabilidade do valor gerado pelo pantanal. Da ultima afirmação conclui-se que tanto a informação biologica, como humana, é necessaria para evitar sobre ou sob estimar o valor das terras húmidas.

A revisão da informação existente, o censo familiar e de grupos, foram empreendidos para identificar os principais conteudos e beneficios das terras húmidas(pantanais) nas quatro áreas de estudo da ZBWCRUP é para fornecer valores estimativos. As quatro áreas de estudo foram:

- Barotse Floodplain na parte ocidental da Zambia;
- Terras húmidas de Chobe-Caprivi;
- Terras húmidas do baixo Shire em Malawi e Moçambique;
- Delta do Zambeze, em Moçambique.

As quatro áreas do estudo diferem marcadamente no tamanho e na densidade populacional. O número de cabeças de gado é relativamente identico nas três áreas de estudo, mas parece ser virtualmente ausente ser no delta. Não obstante, a proporção do gado em relação a população, e muito baixa no baixo Shire, onde as colheitas são mais predominantes do que nas outras áreas. Um modelo estático foi usado para produzir estimativas dos valores financeiros e económicos anuais provenientes do uso directo dos recursos das terras húmidas. Os valores financeiros e económicos são importantes a ter em consideração no contexto da administração dos recursos das terras húmidas na bacia do Zambeze. Os retornos financeiros determinam a atitude da população e dos accionistas e uma compreensão destes valores é importante na medida em que este incentivo encorajará o uso

[1] o valor e obtido de despesas e impostos em mercados identicos.
[2] o valor e obtido atraves de um questionario hipotetico e de recenseamentos.

sustentável dos recursões. Os valores económicos ilustram o valor que as terras húmidas adicionam a economia nacional.

Este estudo sugere que a agricultura tradicional - criação de animais e/ou agricultura, tem um papel dominante na economia domestica nas quatro áreas das terras húmidas. Nem so o valor agricola é atribuido às terras húmidas; parte do rendimento é derivado também das terras altas entre e a volta do habitat das terras húmidas. Os produtos provenientes das terras húmidas, particularmente peixe, fazem uma contribuição substancial na economia domestica das populações.

O rendimento anual liquido por familia proveniente da produção de animais domésticos varia entre US$31 no baixo Shire e US$120 e US$422 nas terras húmidas de Barotse e de Caprivi, respectivamente. O valor económico total de criação de animais que pasta nas terras húmidas, varia de US$1.8 milhão em Caprivi a US$3.9 milhões nas terras húmidas de Barotse. De acordo com nossas estimativas,a agricultura de subsistencia produz um rendimento, por agregado familiar de US$89 em Barotse, e US$295 no baixo Shire. A produção agricola traz benefícios económicos elevados nas terras húmidas do baixo Shire (US$13 milhões) e do delta (US$4.8 milhões), mas incorre custos económicosnas terras húmidas de Barotse e de Caprivi. Os campos são maiores, e os rendimentos particularmente baixos em Caprivi. Os esquemas agricolas de irrigação foram estabelecidos em todos as quatro das áreas das terras húmidas, principalmente para a produção do açúcar e do arroz para finalidades comerciais e de exportação. A informação disponivel, mas limitada de dados indica que os retornos financeiros brutos originados são mais altos em comparação a agricultura de subsitencia. Entretanto, o valor económico destes esquemas tem tendencia em ser baixo. É importante notar que somente uma parte do valor das colheitas pode ser atribuída às terras húmidas, sendo o resto da produção proveniente do rendimento que vem das terras ferteis nas margens dos rios. O valor total da agricultura nessas terras representa o valor da conversão e não o da conservação das terras húmidas.

Certos recursos naturais das terras húmidas são identicos nas quatro áreas estudadas, excepto no delta marinho, estuario e magues, onde os recursos naturais também são utilizados. A população a volta das terras húmidas utiliza peixe, fauna, palmeiras, capim, canico, papiro e plantas comestiveis. As populações do delta fazem também uso da madeira do mangue. O número dos diferentes recursos naturais usados por agregado familiar é relativamente identico nestas zonas, reflectindo afinidades nos modos de vida, necessidades e dificuldades das populações. No delta o aproveitamento do canico e do papiro parece ser reduzido devido a disponibilidade de outro material de construção - a madeira de palmeira.

O pescado é o recurso natural mais importante em todas as terras húmidas e constitui uma fonte significativa de rendimento de uma familia. A industria de pesca declinou nas quatro áreas mas, a área provavelmente mais afectada foi o baixo Shire, onde o rendimento anual proveniente da pesca, por familia de pescadores e não pescadores, e de US$42/hh. A industria de pescas tem o segundo mais baixo rendimento por familia, no delta (US$96/hh). Foi provavelmente e significativamente afectado pelo regime hidrologico que sofreu mudancas desde o encerramento das represas do Kariba e de Cahora Bassa. Familias vivendo nas proximidades das terras húmidas de Barotse e Caprivi ganham uma media de US$174 e US$224 por ano. A pesca, nas diferentes áreas das terras húmidas contribui, anualmente,com aproximadamente entre US$07 a US$8.2 milhões, para a economia nacional.

A caça não é uma actividade de grande relevancia, reduzindo-se a animais de pequeno porte, passaros e rodentes. Estes recursos são ja escassos nas terras húmidas. O número de animais é um pouco mais elevado em Caprivi, onde a fauna ainda é abund ante dada a existencia de contacto entre a área e o Chobe National Park.A fauna nas terras húmidas contribui entre US$0.2 e US$48, por familia, por ano, e entre US$800 e US$15 000, por ano, para a economia nacional, em termos de uso de subsistencia.Estes dados não correspondem, no entanto, a realidade dada a ilegalidade na pratica desta actividade.

No que se refere a plantas e seus derivados, como a producão de esteiras, cestas etc, o rendimento liquido varia entre US$19 e US$129 por familia, por ano e tem um valor económico total entre US$436 000 e US$2.8 milhões.

O valor económico e financeiro liquido total proveniente do uso dos recursos naturais nas quatro áreas das zonas humidas, como área funcional,e fortemente relacionado com a densidade populacio nal o que significa que, a intensidade do uso é directamante proporcional a densidade populacional. De uma maneira geral não ha nenhuma consistencia entre o status económico do agregado familiar e a procura de recursos. Os valores variam e a sua interpretacão difere de grupo para grupo. Nas quatro áreas de estudo, diferentes produtos tendem a ser colhidos por homens ou mulheres e as tarefas de cada um são, equilibradamente, definidas. Estes pormenores não afectam o valor dos recursos das terras húmidas per se, ja que, toda a comunidade beneficia irrespectivamente de como o tabalho é dividido. Entretanto, como ja foi evidenciado em reuniões durante este estudo, os homens tendem em tomar decisões que afectam os produtos colhidos por mulheres assim como o que eles colhem. Isto traz implicações para a sustentabilidade e, a longo termo, pode afectar também o valor económico de muitos recursos cujo grau de escassez não e inteiramente percebido. Embora não seja muito apropriado interferir com as normas culturais destas sociedades, impondo-lhes valores ocidentais, é importante que estes factores sejam tomados em conta durante a formacão e execucão das orientações e programas da administração e educacão no campo da exploracão dos recursos naturais.

O valor do turismo existe ate um certo ponto. Porem, so é considerado em termos de contribuicão para a economia, a área de Chobe-Caprivi, onde o valor económico liquido anual, gerado pelos Lodges existentes e a volta de US$3.6/ha. Isto pode ser atribuido a existencia das terras húmidas. Actualmente, o turismo, nas outras áreas, é fraco. As possibilidades de o desenvolver são limitadas.

As terras húmidas na bacia do Zambeze desempenham diferentes papeis no ecosistema que providencia valor de uso indirecto como forma de suporte a uma variedade de actividades economicas. As funções do ecosistema avaliadas neste estudo incluem a atenuacão do efeito das cheias, o reabastecimento da toalha de agua subterrania e abastecimento de agua, retencão do sedimento, a purificacão da agua e isolamento do carbono. Outras funções importantes do ecosistema das terras húmidas que não foram avaliadas neste estudo, incluem a proteção da linha da costa, o habitat da fauna, reproducão e funções dos viveiros, retencão de nutrientes, regulamento de micro-climas. O valor liquido actual calculado, das funções do ecosistema, varia entre US$22 milhões no Chobe-Caprivi e US$80 milhões no delta, com o valor do isolamento do carbono dominante em todas as terras humdas, excepto no baixo Shire onde os valores de purificacão da agua e reabastecimento de agua subterranea são dominantes.

Os valores de uso indirecto são geralmente da mesma ordem de grandeza que os NPVs (valor liquido actual) referido a usos directos. Não ha dados exactos disponiveis que possibilitem uma avaliacão de se as funções actuais do ecosistema estão sendo utilizadas a um nivel sustentável ou não, embora existam alguns dados qualitativos que indicam que funções de purificacão da agua estão sendo excedidas no baixo Shire enquanto o lencol de agua subterranea não esta a ser explorado. As limitações em dados neste estudo são resultado do uso de métodos simplistas que tendem inerentemente em fornecer estimativas baixas e calculos do NPV (valor liquido actual) deveriam ser considerados como minimos.

O não uso ou ausencia da existencia da diversidade biologica das terras húmidas da Zambia foi calculado empregando o metodo contingente de avaliacão (CVM), usando um questionario. O objectivo principal do inquerito foi verificar a boa vontade dos Zambianos para contribuir para a conservacão da diversidade biologica das terras húmidas de Barotse. Devido ao baixo nivel de instrucão, ao rendimento deficiente, a pobreza das familias das áreas rurais e relutancia das pessoas em responder a perguntas hipoteticas, o questionario foi dirigido aos zambianos que viviam nas zonas urbanas definidas pelo governo como zonas de pessoa empregadas. O resultado reflect assim os valores mais elevados relativos a um grupo minoritario, e traduz uma estimativa minima correspondente ao não uso. Pelo menos 80% dos entrevistados indcou que estava disposto a contribuir om um donativo a uma agencia de conservacão do meio ambiente de modo a ajudar a adquirir fundos suficientes para conseguir direitos sobre as terras húmidas para impedir a conversão em campos agricolas e assegurar a boa conservacão e uso correcto. A media da contribuicão (WTP) por respondente, como pagamento total, de uma so vez, foi de US$35.06, para direitos de conservacão para as principais terras húmidas da Zambia. Uma oferta de ZK18 921 (US$8.90) foi recebida para as terras húmidas de Barotse.Isto traduz um valor total actual de US$16.7 milhões para todas as terras húmidas é US$4.2 milhões para as terras húmidas de Barotse.

O valor estimado do nao-uso é importante para a conservacão e uso correcto das terras húmidas e não para a proteção exclusiva. Inclui também um elemento de valor de opcão, ja que preferencias para conservaco, muitas vezes, vem do desejo de conservar os recursos para para usos no futuro. Tais praticas correctas por partes de gerencias são, normalmente promovidas a nivel internacional pela Organizacão Internacional das Terras húmidas (IUCN) e outras importantes agencias de conservacão. Este estudo indica que tais orientações têm importancia para todos os paises, irrespectivamente do uso.

Varias opções existem para a futura administracão das terras húmidas, incluindo a manutencão do status quo, implementando praticas correctas e viaveis do seu uso, delimitando áreas protegidas e desenvolvendo a comercializacão dos produtos agricolas. Usando um modelo ecologico-económico dinamico mostrou-se que o uso insustentável dos recursos naturais actuais das terras húmidas, minara o seu valor futuro. É provavel que, dentro de vinte anos, os recursos naturais estejam esgotados como consequencia de praticas incorrectas. O status actual das terras húmidas tem estado a ser causado por numerosos factores de origem economica, como a pobreza e sistemas de ocupacão e administracão ineficazes agravados de uma maneira rapida pelo aumento populacional. Valores mais elevados são criados e geridos por uma gerencia ou administracão competente e áreas protegidas so trazem beneficios. Os provaveis custos do desenvolvimento da comercializacão da agricultura estão calculados, porem a implementacão de tais projectos depende da viabilidade economica que, na maioria dos casos é fraca. O cenario ideal de uma administracão de terras húmidas deve incluir, pelo menos, as primeiras tres opções.

Conseguir o uso sustentável ideal das terras húmidas depende, em grande medida da existencia de um plano de acção apropriado.As linhas de orientacão nos quatro paises mencionados sofreram mudancas ao longo da ultima decada com repercussões significativas na administracão e utilizacão das terras húmidas. As orientações macro economicas e sectoriais foram actualizadas reflectindo estrategias em linha com a liberalizacão e privatizacão nacionais. Os planos de acção do sector de recursos naturais têm estado a afastar-se de regimes de protecção para uns em que o envolvimento do estado na conservacão do meio ambiente é reduzido, promove o uso sustetavel dos recursos naturais, e encoraja uma administracão que envolva o sector privado e a comunidade. Contudo, nenhum dos quatro paises associados com as quatro áreas de estudo têm sequer uma instituicão ou linha de acção relacionadas especificamente com as terras húmidas. Assim, multiplos factores institucionalizados afectam os ecosistemas das terras húmidas e afectam também diferentes sectores da economia. As politicas de diferentes sectores que estão ligados a determinadas actividades que usam bens e produtos das terras húmidas, afectando a integridade e o status dessas terras ou definem mecanismos para a administracão das terras húmidas nesses paises icluindo meio ambiente, terra, agua, pesca, sivicultura, fauna, agricultura, urbanizacão e industrializacão. Tipicamente, as politicas sectoriais sobrepoem-se nas áreas que causam preocupacão. Contudo, sectores diferentes são governados por instituições, por leis e por regimes de administracão independente. Ha, quando muito, um interesse parcial nos problemas das terras húmidas, na maior parte dos sectores dos quatro paises mencionados. Isto provoca alguns incentivos directos para administracão e uso sustentável dos recursos. A administracão provoca, em alguns casos, iniciativas perversas que incentivam a conversão e degradacão das terras húmidas. A politica agraria, em particular, esta concentrada em expandir a área cultivada de modo que a terra seja usada na sua capacidade, em lugar de encorajar e incentivar a conservacão de recursos naturais. A orientacão para a industria pesqueira não contem virtualmente, nenhuma referencia ao ecosistema das terras húmidas, ou ao seu papel em manter os recursos pesqueiros, e o seu objectivo principal de intensificar a actividade da pesca pode causar a sobre exploracão das terras húmidas e a sua utilizacão insustentaval. Uma recomendacão chave deste estudo e que as orientações respeitantes às terras húmidas, sejam definidas nos paises de ZBWCRUP. Estas orientações devem definir acções a nivel regional, nacional e local e devem centrar-se, fundamentalmente, no uso dos instrumentos económicos e dos incentivos que consigam o uso sustentável ideal das terras húmidas.

O objectivo de ZBWCRUP da utilizacão é administracão sustentável das terras húmidas e, indubitavelmente, limitado por fraquezas e omissões da politica nos paises da bacia do Zambeze que falham em apresentar incentivos adequados para a conservacão. Alem disso, as iniciativas regionais da administracão das terras húmidas, incluindo Zambezi Actin Plan, e os diversos acordos e convensões internacionais tocando problemas das terras húmidas, são centrados mais na avaliacão e em planeamento do que na sua implementacão pratica. Esta situacão necessita urgente atencão se a utilizacão futura das terras húmidas do Zambeze vai ser controlada de de forma a ser sustentavel.

Para finalizar, este estudo fornece uma breve perspectiva economica da iniciativas da ZBWCRUP para a administracão das terras húmidas que tem sido levada a cabo nas quatro áreas de estudo, pelos funcionarios do projecto de campo. As actividades do projecto estão centradas em: (i) melhorar o bem estar da comunidade; (ii) consciencializacão e treino assim como o inventario; (iv) controle dos recursos e (v) administracão dos recursos.

A miaoria destas acções e mecanismos tem implicaaões para a coservacção e o utilizacão dos recursos naturais. Estes actividades têm tendencia em concentrar-se no bem estar comunidade. Isto é essencial a fim de ir ao encontro dos objetivos de conservacção, mas é também importante realcara que reduzir as carencias das pessoas não muda necessariamente o seus desejos e ambições. Este problema é abrodado com masi eficiencia atraves de actividades que aumentam as suas aspirações. Assim os primeiros dois tipos de actividades são dee longe muito mais eficazes se forem postos em practica ao mesmo tempo. A informação na disponibilidade e no uso dos recursos é também essencial para estabelecer e influenciar testes padrões para o uso sustentavel, mas têm havido relativamente pouca actividade nesta área. A maioria das iniciativas de administraccoa têm sido implemetades somente recentemente. Isto inclui projectos para reduzir a pressão em recursos utilizando tecnologia apropriada em Chobe-Caprivi, para reduzir conflitos homen-fauna no baixo Shire e para explorar recursos sob-explorados e restaurar mangues no delta. A tecnologia melhorada introduzida para uso dos fogões a lenha no Chobe-Caprivi tem a capacidade de reduzir a procura de lenha sem que isso tenha um efeito cultural negativo. Embora não usando os recursos do terra humidas, tal tecnologia podia melhorar o novel de vida e reduzir a prcocura de outras plantas usadas para combustível em áreas de terras húmidas. A fauna incorre em custos nas comunidades das terras húmidas, e as iniciativas que reduzam estes custos e ou tragam benefícios dos mesmos animais, aumentariam os benefícios das terras húmidas para às comunidades assim como, melhorariam atitudes em relacção a conservacção. Nem o plano e administração dos crocodilos no baixo Shire, nem o projecto da restauração do mangue do delta de Zambeze, serão capazes de gerar lucros, mas poderiam ser economicamente efficientes, se as mudanças em todos os valores económicos fossem tomadas em conta. As decisões sobre se se deve prosseguir com estes projetos, ou não, devem ser baseadas nos critérios ó mais amplos. As iniciativas para explorar recursos novos ou sob-aproveitados têm capacidade para produzir rendemento sustentabilidade, mas é imperativo que o fornecimento e a procura sejam bem investigados. Entretanto, este tipo de pesquisa é a longo prazo e fora da competencia deste projeto. As iniciativas da administração nas áreas do estudo incluem também reformas institutionais, tais como o estabelecimento de comitês de gerência locais, em Barotseland, e o melhoramento e segurança na proteccar não ocupacção de terra no delta. Enquanto o último é apropriado no delta onde sistemas tradicionais de administração communal foram corroídões, o anterior tem a finalidade de reforccar e assegurar a sustentibilidade de sistemas tradicionais de administração onde estes têm ainda alguma influência. Concluindo, iniciativas necessitam de uma abordagem mais coordenada e mais focada, que se dirija a regimes da propriedade comum, na reducção da pressão nos recursos, a instrução, a administração e treino nessa ordem de prioridade.

1 INTRODUCTION

1.1 BACKGROUND AND RATIONALE

The Zambezi River basin system, with its associated tributaries and wetlands, forms a prominent natural resource spanning several countries in central-southern Africa. Its biodiversity is poorly known but preliminary collation of information suggests that the system is of international conservation importance (Timberlake 1997). The various components of the system, and the wetlands in particular are relied upon by, and thus of considerable value to, large numbers of people in Zambia, Namibia, Botswana, Malawi, and Moçambique.

The Zambezi Basin Wetlands Conservation and Resource Utilisation Project (ZBWCRUP) was initiated in recognition on the part of the Southern African Development Community (SADC) states that widespread deterioration of wetlands has occurred in the region. In these areas, and globally, wetlands are being depleted by man faster than they are being created. Threats to wetlands are many and varied, and include changed water flow regimes, through abstraction, damming or catchment alteration, reclamation and conversion, pollution, and overexploitation of natural resources. Although these threats are increasingly being recognised, there is still greater pressure to develop or convert wetlands than to conserve them (Barbier *et al*. 1997). Wetlands are known to have important socio-economic attributes and, although these values are not yet well articulated or quantified, wetland deterioration and the commensurate loss of the resource base of communities causes considerable concern. There is a need to understand these values, and the socio-economic processes that lead to their degradation, in order to achieve optimal harmonisation of socio-economic and conservation goals at the site, national and regional levels.

Economic decision making and policy formulation are based on available information on the costs and benefits of alternative activities, and usually aims to satisfy the goals of efficiency, equity and sustainability. The efficiency criterion is that any action is desirable if the benefits outweigh the costs, and the optimal option in this regard is the one with the maximum net benefit. The equity criterion is that the costs and benefits should be fairly distributed among members of society. While valuation may tend to concentrate on the efficiency criterion in decision making, by comparison of costs and benefits, it does not usually explicitly address the equity issues, or the distribution of these costs and benefits. The sustainability criterion is that the welfare of future generations is not compromised by the acquisition of benefits by the current generation. Thus in order to make decisions regarding the use of natural resources such as wetlands, it is necessary to understand the costs and benefits associated with alternative uses of the wetlands e.g. preservation, conversion to rice paddies. In the past, decisions have been made without recognition of the value of many of the goods and services associated with wetlands in their natural state. It is often stated that the values of the direct uses of wetlands, such as fisheries, are well known, but the indirect and other values associated with wetland ecosystems and their biodiversity are usually left out of the equation. In developing countries, however, even the direct use values for subsistence users are often unknown. Due to the lack of information about wetland values, their conversion and development has up till now generally been perceived as the more attractive option, generating obvious, tangible benefits such as government revenue and clearly visible economic development and growth.

IUCN has been funded by the Canadian International Development Agency (CIDA) to address this situation with an over all project goal "to conserve the critical wetlands of the Zambezi River Basin". The project is being managed by IUCN-ROSA in Harare, where projects of regional scope are undertaken.

One of the project's three major objectives is "to articulate the true value and importance of the goods and services provided by wetlands at the local, national and regional levels". In the Logical Framework Analysis, which was produced as one of the steps in rationalising the project's viability, an analysis of risk was conducted which included a number of critical assumptions. One of these was that the value of wetlands goods and services are quantifiable, which, in turn, hinges on the emerging science of environmental economics. Hence the need for an economic valuation component of the project was recognised.

Three main problems requiring the application of resource economics have been identified:

1. There is a lack of basic information regarding the economic values of the goods and services provided by wetlands, including biodiversity, in the Zambezi Basin. Thus the economic importance of the Basin's wetlands is not known at local, national and regional levels. Furthermore, the biophysical and social limitations to the use of productive services of wetlands are largely unknown and, in many cases, the root causes of environmental degradation and over-exploitation are not understood.

2. It is evident that the role of wetland ecosystems, their ecological and economic value to local and distant communities, and associated limits to sustainable use, are not fully appreciated by individuals making or influencing resource utilisation decisions. These include government, community leaders, the media, donors and NGOS.

3. The institutional capacity to manage wetlands ecosystems and their dependent human populations in an integrated fashion, and thus to plan and implement appropriate and sustainable development initiatives, is lacking. Of particular concern is the lack of institutional capacity to carry out comprehensive assessments of wetland values.

The Environmental Affairs Directorate (DEA) of the Namibia Department of Environment and Tourism, in conjunction with the FitzPatrick Institute, University of Cape Town, was commissioned to address these problems.

While valuation is vital to ensure economically sound conservation and development, it is not a panacea (Barbier *et al*. 1989). Effecting complete valuation is difficult due to insufficient information on ecological and hydrological processes, and efforts at valuation usually lead to a call for further scientific research. However, even basic valuation helps to arrive at better informed decisions.

While there is, indeed, concern over all the wetlands in the Zambezi Basin, four specific wetland areas have been chosen for the project. These are hereinafter referred to as "field sub-projects" and are the:

- Barotse Flood Plain in Zambia
- Chobe-Caprivi area in Namibia and Botswana
- Lower Shire wetlands in Malawi and Moçambique
- Zambezi Delta in Moçambique

1.2 AIMS OF THE STUDY

Tasks to be performed in this study will be aimed at satisfying the following long-term objectives.

1. To assess the economic values of natural resources in selected Zambezi Basin wetlands, to identify existing disincentives for their sustainable use and to provide recommendations for future management.

2. To facilitate inter-disciplinary and international exchange of information concerning the role and values of wetland ecosystems.

3. To communicate biodiversity and natural resource values, and the need to protect them, to communities, planners, resource managers, politicians and the public.

4. To build capacity in environmental and resource economics in the region.

5. To provide official encouragement to Zambezi Basin states to develop appropriate land tenure, development, resource use and conservation policies that ensure sustainable use of wetlands across national boundaries.

The project was divided into two phases. The first phase of the project, involved initial assessments of value and the formulation of a proposal for phase two. Phase I was carried out over a 6 month period, and Phase II was carried out over one year.

The main aims and activities for the Phase 1 study were as follows:

1. To identify regional expertise in wetland valuation techniques as well as appropriate institutions in which to build capacity.

2. To identify Botswana, Malawi, Moçambique, and Zambia expertise and institutions with an interest in economic valuations of wetlands goods and services and involve them in the project to the maximum degree possible.

3. To prepare a framework for the enhancement of institutional capacity through training in resource economics which can be put into action during the second phase of the wetlands economic valuation project.

4. To provide a summary of project requirements for capacity building in wetlands valuation techniques, considering training in its broadest sense to include a variety of mechanisms such as on-site communication and demonstration, training of Field Project Officers etc.

5. To provide limited economic valuation training to Field Project Officers on an opportunistic basis during field visits.

6. To document methodologies for determining the value of wetlands goods and services.

7. Through reconnaissance visits, to become familiar with the field sub-projects, their communities and socio-economic systems.

8. In co-operation with the contractors for the ZBWCRUP biodiversity study, to initiate an assessment of the socio-economic values of biological diversity with specific reference to the four field sub-projects, and making specific reference to the report on Phase I of the biodiversity study.

9. To interact with the ZBWCRUP Project Manager and Field Project Officers in order to obtain existing information on the local, national and regional values of wetlands goods and services pertaining to the four field sub-projects. Background information available from the ZBWCRUP, to be used by the contractor will include, but not be limited to, assessments of existing related literature, community based studies of resource consumption, inventories of forests, wildlife and fish populations, special studies on fuel wood and fish supply and consumption, etc.

10. To apply environmental and resource economics techniques to valuation of wetlands goods and services at the community, national and regional levels and to compare and contrast these values under different wetland management and socio-economic scenarios.

11. To make a preliminary assessment, in monetary terms, of the economic values of goods and services provided by wetlands ecosystems in the four field sub-projects, as far as possible, using existing information.

12. To evaluate specific components of these wetlands ecosystems as economic producers.

13. To provide economic perspectives to specific wetlands management initiatives in the field sub-projects such as those designed to reduce human - wildlife conflict.

14. Where feasible, to identify those components of existing policies in Botswana, Malawi, Moçambique, Namibia, and Zambia that affect the use of wetlands goods and services and specify how they act as incentives or disincentives to sustainability.

15. To undertake a preliminary analysis of the extent of policy implementation and the effectiveness of such policy in the decision making processes in the region.

16. To establish a user-friendly electronic data base incorporating all information generated for and by the project.

17. To formulate a detailed proposal for the second phase of the economic valuation project.

The results of the first six-month phase, reported in Turpie *et al*. (1998), served as the basis for the second phase of the study. Work done during Phase I highlighted the magnitude of the task of estimating the value of four large wetland areas in the Zambezi Basin. The data requirements were identified as being immense, and far exceeding the amount and quality of data that already existed. In light of the limited time allocated to the second phase of the study, it was necessary to focus to some extent on the most critical issues that are pertinent to achieving the ZBWCRUP goals of sustainable use and conservation of these areas, and to find cost- and time-efficient ways of addressing them. The main emphasis of Phase II was to build on the work of Phase I, refining the estimates of wetland values, with the ultimate aim of formulating policy recommendations.

Whereas the second phase of the ZBWCRUP Biodiversity Study has concentrated on the two richest areas from a biodiversity point of view, Barotseland and the Delta, the economic valuation study has continued to address all four areas. From an economics point of view, it is very important to consider the wetlands in which natural resources are being, or are close to being, overexploited, as well as those in which resources are under-exploited or well managed.

The main aims for the Phase II study were as follows:

1. To refine initial estimates of the use values generated by the wetlands, taking sustainability into account as far as possible, and develop rough estimates of the magnitude of indirect use and non-use values as far as possible;

2. To identify the trade-offs and linkages between different wetland uses and values, and discuss how land-use and management plans can be designed to maximise the total economic value of wetlands;

3. Based on the above findings, to contribute to development of appropriate policy which promotes the conservation and optimal sustainable use of wetlands by means of policy scenario analysis and generation of a wetlands policy framework suitable for application at the national and regional levels;

4. To build capacity and disseminate information on wetlands valuation and values.

With more detailed study, many of the preliminary estimates made in the first phase have changed. This report is presented as an almagamation of the work carried out in both phases of the study, and replaces the preliminary Phase I report (Turpie *et al*. 1998). The results of the resource economics capacity assessment are included in Appendix 1.

2 WETLAND VALUATION: A REVIEW

2.1 INTRODUCTION

Many studies have been carried out on wetland valuation (e.g. Barbier 1989, 1993, 1994, Bergstrom *et al*. 1990, Costanza *et al*. 1989, Gren *et al*. 1994, Ruitenbeek 1994), but there has been little in the way of synthesising this literature to find a common approach (Barbier *et al*. 1997).

The aim of this chapter is to provide a brief overview of existing natural resource valuation methods that can or have been used in wetland valuation studies. An outline is given, but the reader is referred to the references for more detailed aspects of these methods, and for case study examples. The applicability of these methods for measuring wetland values in an African rural context is discussed. Finally, the presentation and interpretation of values derived by these techniques is discussed.

2.2 THE CONCEPT OF VALUE

The word "value" can have a number of interpretations. In the valuation of natural resources, it is normally meant in the sense of a measure of social welfare. There is no standard measure for social welfare, however. To the economist, scarcity is what imparts value to a good or service. This is usually reflected in market prices. Thus, the value of a commodity (good or service) is generally accepted as society's willingness to pay for it, less the costs of its production. Society's willingness to pay for commodities is the aggregate of individual willingness to pay, and comprises actual expenditure plus consumers surplus.

In many cases, the costs of production are zero or negligible, and the environmental goods or services have the characteristics of "free goods", such as clean air or sunshine. Many environmental goods and services are thus unpriced, implying, often incorrectly, that they are in unlimited supply. It is the measurement of unpriced economic value which presents the greatest problem in any economic study of an environmental asset.

The value of unpriced or inappropriately-priced environmental commodities can be gauged by observations of people's actual behaviour, or can be elicited by means of direct questioning.

2.3 TYPES OF ECONOMIC VALUE OF WETLAND RESOURCES

Natural resources such as wetlands yield a number of goods and services of economic value to society and also possess other attributes of value. These goods, services and attributes relate directly to the ecological characteristics of wetlands (Table 2.1).

Table 2.1. A comparison of ecological and economic characteristics of wetlands (adapted from Aylward & Barbier 1992).

System characteristics	Ecosystem characteristics	Economic characteristics
Stocks	Structural components	Goods
Flows	Environmental functions	Services
Organisation	Biological and cultural diversity	Attributes

The complexity of the concept of value of natural resources and their measurement has led to the development of a hierarchical breakdown of total economic value into component values (Turner 1991, Munashinge 1992, 1994). Although it is often difficult to separate these types of value in practice, this breakdown provides a useful starting point for the identification of different values and for the design of a methodology for their measurement. Thus total economic value is usually broken down as follows (Fig. 2.1)

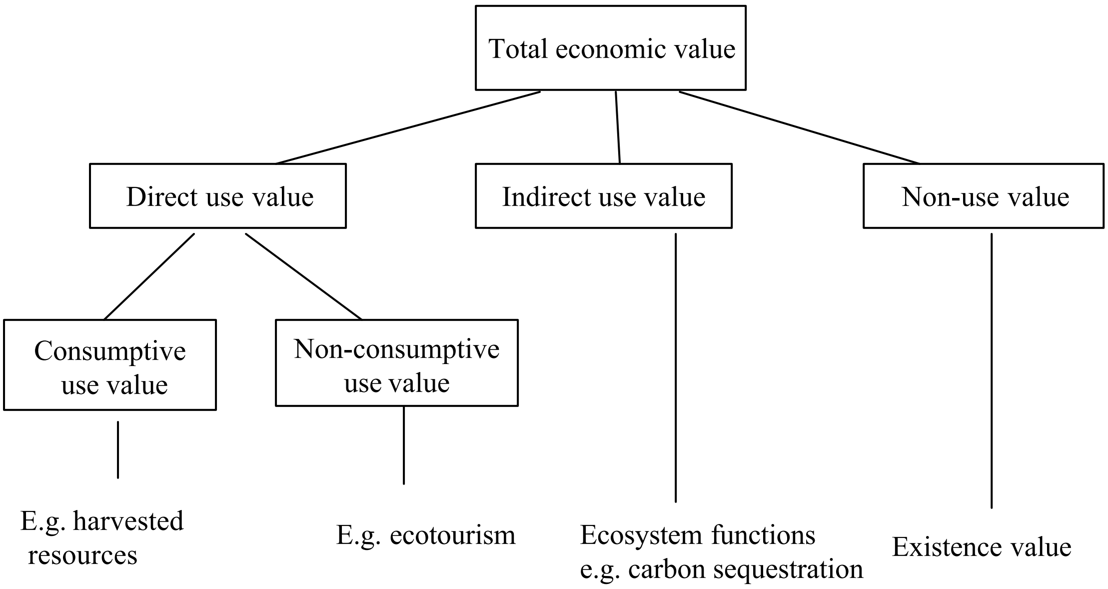


Figure 2.1. The hierarchical breakdown of types of economic value of natural resources (after Munashinge 1994).

The types of value shown in Fig. 2.1 are decreasingly tangible and increasingly difficult to measure from left to right.

Direct use values are the easiest kind of environmental benefits to envisage, and comprise both consumptive use and non-consumptive use value. Consumptive use value is obtained from harvesting resources, or wetland 'goods'. Non-consumptive use value such as that obtained from the recreational enjoyment of a resource is associated mainly with the 'attributes' of a wetland.

Indirect use values are the benefits obtained from ecological functions, or 'services', of the wetland. These include climate regulation, nutrient cycling and storage (or water quality regulation), aquifer or groundwater storage and recharge functions, storm protection from tidal surges and winds, shoreline anchoring and buffering against erosion, geochemical cycling and local stabilisation and food web support (Turner & Jones 1991).

Option value, sometimes called future use value, is the value that people place on retaining the option to use a resource in the future, irrespective of whether it is any use to them at present. This value is variously described as a use value or a non-use value.

Non-use value, also called 'existence value' is the value of knowing that a resource exists, even if that resource is remote and is never used directly. Existence value is often expressed in peoples' willingness to pay for the conservation of endangered species in far-off places. At a more prominent international level global willingness to pay for the existence of natural resources is reflected in debt-for-nature swaps. For example, an amount equivalent of US$ 454 000 (1990) was paid in 1989 for the Kafue Flats and Bangweulu wetlands in the Zambezi Basin in Zambia (Pearce 1993).

Whether or not the different types of values associated with natural resources can actually be summed is a contentious issue. In particular, expressed existence values are fairly difficult to decouple from other types of values. It is also necessary to recognise that many of the values identified are conflicting values or trade-offs. For example, the value of grazing and thatching may compete, if livestock graze the same species used for thatching. Similarly, the game viewing value of a wetland may not be additive with its potential sport-hunting value. In many instances, wetlands are valued in terms of their ability to act as water treatment plants. However, it is important to realise that this is effectively valuing the conversion of the wetland if this service negatively affects other values such as tourism.

Wetlands are not ecologically uniform, and different wetland habitats yield different values. Some examples of the types of value associated with the main wetland habitats within the Zambezi basin are listed in Table 2.2.

In the case of goods provided by the wetland, e.g. fish, wildlife and plant products, the wetland value will be a function of size and productivity. Direct and indirect values associated with the floodplain will be a function of hydrological regime as well as size. The non-consumptive use values, or tourism value, associated with the whole wetland will be a function of the heterogeneity or habitat composition of the wetland as well as its size and quality.

Table 2.2. Direct and indirect use values associated with different components of wetlands systems that occur along the Zambezi River Basin. Non-use value applies to all habitats.

Wetland component	Direct use value	Indirect use value
River and channels	Fish Reptiles	
Riparian zone	Reeds Wood, Fruits Mammals Birds	Breeding habitat for fish and waterfowl
Palustrine wetlands e.g. reedmarsh, papyrus swamps	Reeds Fish, birds Mammals	Nutrient cycling and pollution absorption
Estuary (including mangroves)	Invertebrates Fish Wood	Coastal/marine fishery productivity (nursery function) Protection from coastal erosion Sediment trap (protects coral reefs)
Floodplain	Fertile agricultural soils Grasses, Grazing Wood (palms & other floodplain species) Mammals, Birds	Groundwater recharge
Whole wetland	Biodiversity and aesthetic beauty – non-consumptive tourism value	Flood attenuation

[1] Includes game with both negative and positive values, e.g. hippopotamus, crocodiles.

2.4 AN APPRAISAL FRAMEWORK FOR VALUATION

Barbier (1994) introduced a framework to valuation studies as follows:
1. Choose appropriate general assessment approach within which to apply valuation methods.
2. Define the scope and limits of the valuation and information needs:
- geographic and analytical boundaries,
- time frame,
- identify the basic characteristics of the wetland(s) in terms of structural components and functions, and also attributes, e.g. biodiversity, cultural uniqueness,
- determine the type of value associated with each, e.g. direct consumptive use value
- rank the major characteristics and values, e.g. in terms of relevance to the study, or contribution to overall value

tackle the most important values first, and the least important only if it becomes necessary.
3. Define data collection methods and valuation techniques.

2.5 ECONOMIC VALUATION TECHNIQUES

The methods used to value economic goods and services of wetlands are no different from the methods used to value any other type of environmental assets. Different types of value are each measured with a different choice of methods. The number of possible methods that can be used to measure the different types of values also decreases from left to right along Fig. 2.1 (see Table 2.3). Direct consumptive use values can be estimated using any of the techniques discussed below. Compared to other types of value they are most amenable to market-value techniques. At the other end of the spectrum, option and existence values can only be measured by direct questioning, using contingent valuation methods, to ascertain peoples' willingness to pay (Table 2.3). Option value is seldom measured explicitly and is also fairly difficult to separate in practice from existence value.

Table 2.3. Commonly-used natural resource valuation methods, and the types of value which they are generally used to measure.

	Direct use values Consumptive	Non-consumptive	Indirect use values	Option and non-use value
Market price/ shadow price/ surrogate price methods	ŏŏ	ŏ		
Net Factor Income	ŏŏ	ŏ		
Production Function	ŏŏ	ŏ		
Replacement Costs etc	ŏ	ŏ	ŏŏ	
Travel Cost Method	ŏ	ŏŏ		
Hedonic Pricing	ŏ	ŏŏ	ŏŏ	
Contingent Valuation Methods	ŏŏ	ŏŏ	ŏ	ŏŏ

Valuation methods can be divided into three main categories: market-value approaches, surrogate-market approaches and simulated market approaches. While surrogate- and simulated-market approaches measure the demand for natural resources, and hence, willingness to pay, market value approaches are based on prices and do not necessarily include consumer surplus (see Turner *et al*. 1994) The latter group of techniques thus normally underestimate benefits. Each of the most commonly used methods is discussed below, and their applicability in the context of wetland valuation in rural, developing-countries in Africa is discussed. The published literature tends to pigeonhole environmental valuation techniques into discrete methods. However, it is important to note that many of the 'methods' mentioned in the literature do not stand alone as valuation techniques, but form part of an overall approach. The following discussion thus deviates somewhat from the standard layout of valuation methodology descriptions.

2.5.1 Market value approaches

2.5.1.1 Value of direct wetland outputs

For those direct wetland uses which primarily involve harvesting of wetland resources (e.g. fish, reeds), the annual use value of each good can be calculated as follows:

Annual use value = Q x (P-C),

where Q is the quantity of units used annually, P is the market price and C is the cost of harvesting the resource. This measure of value is equivalent to consumer expenditure, and may not include consumer surplus. This method relies on the measurements of price, harvest costs and the quantities harvested annually.

Measurement of price:

(1) MARKET PRICE METHOD

Where market prices for harvested resources are available, these should serve adequately as measures of value (Barbier *et al*. 1997), unless price distortions are expected. The type of price used should be stated explicitly in valuation studies. Prices are usually taken at the 'farm-gate' level, in other words price accepted by the harvester, before any value is added to the resource by marketing or processing.

(2) SHADOW PRICE METHOD

Under certain conditions, market prices may not reflect the true value of a resource. Prices may be distorted by conditions of imperfect competition, for example when local markets are relatively isolated, or through government intervention. As an illutstration, maize prices may be set at levels lower than international market levels in order to protect local consumers and higher than international market levels in order to protect local producers. If distortions are suspected, the use of shadow prices is usually advocated (Barbier *et al*. 1997), but only if they can be adequately estimated (James 1991). Shadow prices are corrected prices, to account for the distortions, and aim to reflect the full value of a commodity to society. They thus reflect economic value rather than financial value. However, the proper correction of distorted prices relies on accurate diagnosis of the direction and magnitude of the distortion, which is often difficult.

(3) SURROGATE PRICE METHODS

If no market prices are available for a resource, as is often the case in subsistence economies, then surrogate prices can be used. There are several possible ways of doing this (Barbier *et al*. 1997):

(a) *Barter or trade value*: If the resource is bartered or traded, e.g. fish for rice, then it may be possible to estimate its value based on the market value of a commodity for which it is traded. This method requires information about the rate of exchange between two goods. If such trade is not observed the information can be obtained using properly-designed survey instruments, e.g. ranking techniques in a focus-group discussion.
(b) *Substitute price*: If a close substitute can be identified which has a market value, then it is possible to assign the value as the price of the substitute. This requires information about the degree of substitution between different goods.
(c) *Opportunity cost*: Alternatively, it is possible to derive a minimum value for a good by estimating the opportunity cost of inputs required for its harvest or production.
(d) *Indirect substitute prices*: In the absence of all the above possibilities, and when the substitute is also unpriced, then it may be necessary to use the opportunity cost of the substitute as a proxy for the value of the commodity in question.

Measurement of harvest or production costs

Where inputs, such as fishing nets, are required, their costs can be estimated directly using market prices. The costs of harvesting wetland resources also includes labour time, which is usually taken as some proportion of the wage rate, or the shadow price of labour. Where opportunities for formal and informal employment are very low, the shadow price of labour time to collect natural resources approaches zero. This is a complex issue, however, as all time could be said to have an opportunity cost in terms of other tasks or recreational activities that could be being carried out.

Measurement of wetland outputs

Output levels, or the quantities of wetland resources harvested, can be estimated in a number of ways depending on the accuracy required. Although much attention is given in the literature to the measurement of value in valuation studies, comparatively little is said about the measurement of quantity. Quantities of outputs can be measured by direct observation, such as records of fish landings, or by survey instruments. The latter can be in the form of straightforward questionnaire surveys, focus group discussions, or data obtained by means of Rapid Rural Appraisal techniques. Although questionnaire surveys theoretically provide the most statistically rigorous quantitative data, there are many problems with such surveys that are better addressed by the more participatory techniques. In all cases, it is important to take variability, such as seasonal variability, into account when quantifying resource use.

2.5.1.2 Value of indirect wetland outputs

This approach is used when the wetland provides an unpriced input into the production process, for example, the view of a natural wetland as an input into a tourism venture.

(1) NET FACTOR INCOME METHOD or VALUE ADDED APPROACH

The net factor income approach, also called the 'residual approach' (James 1991) or the 'net value added approach' (Barnes & de Jager 1996), provides an estimate of the contribution of the wetland to output value in the production process. If all the other inputs are priced, then the wetland value is estimated as the gross income from the final product minus the costs of the priced inputs. As with the market price methods above, this is a static estimate of the value of the wetland inputs under existing circumstances. With complex data on capital and fixed and variable costs, it is possible to assess the value of the input of an environmental variable such as wildlife stock units in terms of value added to the national economy in commercial enterprises, using static spreadsheet models (e.g. Barnes & de Jager 1996).

Similarly the contribution of natural resources such as grazing to cattle production can be calculated using spreadsheet models. The quality of the result is largely dependent on the amount and quality of data that is entered into the model, as well as on the nature of the model itself.

2.5.1.3 Change in productivity

The methods described above to value the direct and indirect outputs of wetlands cannot themselves be used to predict the change in output value that will occur with a change in wetland area or quality. However, they form the basis of the "change in productivity or change in income" approach, in which the values of outputs are compared under alternative scenarios such as change in wetland area or with- and without-development scenarios.

(1) THE PRODUCTION FUNCTION APPROACH

Both in the case of direct wetland outputs and indirect outputs where wetlands contribute to the production of other outputs, change in productivity associated with a change in wetland area or quality can be estimated using the Production Function approach (e.g. Ellis & Fisher 1987, Barbier 1994). This involves the estimation of a production function which has the wetland good or service as an input, follows:
$Q = f(S, X_i \ldots X_n)$

where Q is the commodity produced by the stock of wetland resources (S) along with other inputs, X (after Barbier 1994).

This approach demands far more detailed information than the static approaches described above, as it requires an understanding of the relationship between the output and the state of the environment, or the physical effects on production of changes in a wetland resource. This is usually achieved through time-series or cross-sectional analysis, and thus usually requires data spanning a number of years or comparable data from a number of wetland areas. The production function approach makes it possible to examine the effects of marginal changes in the wetland inputs, for example the effect of change in wetland area on fishery output.

The production function approach is considered to be a particularly promising approach to valuing certain environmental functions of tropical wetlands (Barbier 1994). However, it is important that the relationship between the wetland function and the economic activity it contributes to is well understood.

2.5.1.4 Cost-based valuation

Some wetland goods and services can best be valued in terms of the costs that would be incurred if they were lost. This is especially useful in valuing ecological services such as the protective function of wetlands (e.g. flood mitigation).

(1) RESTORATION COST or REPLACEMENT COST METHODS

This uses the costs of restoring ecosystem goods or services (e.g. through habitat restoration), or of replacing them with artificial substitutes. Replacement costs are usually easier to estimate than restoration costs.

(2) DAMAGE COSTS AVOIDED

This method estimates the cost of the damage that would be incurred with reduction or loss of the wetland. It usually has to incorporate some type of probability analysis to estimate the probability and degree of damage that would occur. This method assumes that damage estimates are a measure of value, or in other words, that the damage is worth avoiding.

(3) DEFENSIVE (AVERTIVE) EXPENDITURE METHOD

This method takes the costs of preventing damage or degradation incurred on environmental benefits as a proxy of the value of those benefits. For example, the value of storm protection by coastal wetlands could be measured as the cost that would be incurred in building dykes if a coastal wetland was reclaimed.

2.5.2 Surrogate market approaches

(1) TRAVEL COST METHOD

This technique is used primarily for the valuation of recreational benefits of environmental amenities, especially in cases where visitor fees are low or non-existent (e.g. Clawson & Knetch 1966, Willis & Garrod 1991, Turpie 1996). The method derives willingness to pay for the use of an area from observed visitor behaviour. It is assumed that the money and time spent on visiting a recreational site is a proxy for the value of that site. Information on travel costs is used to derive a demand curve for the site, from which the consumers' surplus can be calculated. The demand function incorporates a number of factors which might influence peoples' visitation rates. It is possible to apply either a Zonal TCM or an Individual TCM. For a zonal TCM, which is the preferred method, the visitors are divided into a number of origin zones based on travel distance from the recreational site, and the number of people coming from each origin zone and the average travel cost from each origin zone are calculated.

The data requirements for a travel cost estimation are quite substantial and include the use of questionnaire surveys. Data requirements include the number of visitors to the site, their origin, socio-economic characteristics, the duration of the journey and time spent at the site, direct travel expenses, values placed on time by the respondent, and purposes of the journey other than visiting the site. The cost of visiting the site includes the opportunity cost of time, and the method of estimation of this opportunity cost is controversial (Smith *et al*. 1983, Matthews *et al*. 1987, Shaw 1992). The shadow price of time is often taken to be about a third of the wage rate, but it is not always considered appropriate to apply an opportunity cost to recreation time at all.

Data on travel costs are then used to estimate the demand curve for that site using multiple regression analysis. The multiple regression is used to isolate the specific response to the environmental variable. The demand relationship is generally described by a semi-log function in which the logged visitation rate is negatively correlated with the travel costs to the recreation site. Visitors' consumer surpluses are then calculated by integration.

Although relatively straightforward in theory, the Travel Cost method is often complicated by several factors. The most confounding problem is that of journeys to multiple destinations, in which case it becomes difficult to isolate the value of the site in question from that of other destinations on the journey. Another difficulty is accounting for substitute sites. A visitor may travel 20 km to visit a site which they particularly enjoy, whereas another who has less enthusiasm for the area may travel the same distance because there is no other available recreational site near home. The travel cost method would assume they have the same recreational value (or willingness to pay) for the site. Some people may have low travel costs because they choose to live near the site in order to gain easier access. The travel cost method also is unable to account very well for the value held by people that walk or cycle to the site (JKT, unpublished data).

(2) HEDONIC PRICING METHOD

Through multiple regression of the different variables that contribute to property price, it is possible to calculate the contribution made by the environmental variable (such as a view or storm protection). This is because the value of environmental amenities is reflected in the prices paid for property, such that

$P = f(E, X_1, X_2 \ldots X_n)$

where E is the environmental variable and $X_1 .. X_n$ are variables such as size, aspect or building attributes.

This method is inappropriate in situations where there is no market for land, such as in communal lands of most parts of rural Africa.

2.5.3 Simulated market approaches

(1) CONTINGENT VALUATION METHODS

Contingent valuation methods elicit peoples' willingness to pay for access to or the existence of natural resources by means of direct questionnaire survey techniques (e.g. Mitchell & Carson 1989). In the survey, a hypothetical question (or set of questions) is posed to each of the respondents which elicits their willingness to pay for the preservation of resources or their willingness to accept compensation for the loss of resources. The method can be applied in a number of ways, and can approach the problem directly or indirectly. Willingness to pay can be elicited by means of open-ended questions, referendum or dichotomous choice (yes-no) type questions, bidding games, trade-off games, ranking techniques, costless-choice options, or the priority evaluator technique. The method usually has to be tailored to suit each unique valuation situation.

Contingent valuation is the only method with which to estimate option and non-use values, and it has also frequently been applied to the measurement of recreational use value. Contingent valuation methods can also be applied to the valuation of direct and indirect goods and services associated with natural systems where the quantification of these outputs is difficult.

Because they rely on direct questioning rather than observing people's actual behaviour, contingent valuation methods are open to a number of biases. Indeed much of the academic literature on contingent valuation has paid attention to these biases and to finding ways of minimising them (e.g. Bishop & Heberlein 1979, Willis & Garrod 1991b, Cooper & Loomis 1992, Carson *et al*. 1996). An important bias to be wary of is 'strategic bias' whereby respondents over- or understate their true willingness to pay because they believe their response may influence decision making. 'Embedding bias' occurs when people do not see the question in the context of all their wants, needs and budgetary constraints. 'Interviewer bias', 'Information bias', 'starting point bias' and 'hypothetical bias' tend to steer the thinking of the respondents, and decisions are also influenced by the choice of payment vehicle (e.g. taxes or donations). Because of these biases and the difficulty in their resolution, the use of contingent valuation methods in valuation studies is somewhat controversial. This controversy led to the formation of a panel which examined the validity of the method and formulated guidelines as to its application (Arrow *et al*. 1993). Thus, if used properly in such a way as to minimise bias, it is deemed an acceptable method of measuring value (Arrow *et al*. 1993).

Among the recommendations of the NOAA panel, is that interviews should be face-to-face rather than telephonic or postal and they should be pre-tested. The valuation question should be in a willingness-to-pay rather than willingness-to-accept format where possible, and should be a referendum-type (yes-no) question, rather than open ended. However, when using a single referendum question, a sample size of at least 1000 respondents is required. Accurate information should be presented, and respondents should be reminded to consider their own budgetary constraints and expenditure preferences other than the issue in question.

As for travel cost surveys, contingent valuation surveys also obtain information on socio-economic factors, distance from site, etc in order to construct a demand curve from which the net social value can be estimated.

As with other valuation methods, contingent valuation methods have largely been developed in countries of the North. The application of contingent valuation methods in rural developing countries is somewhat more difficult and controversial than most methods (see section 2.6), and when rigorously applied, this is the most costly valuation technique.

2.5.4 Benefits transfer

In certain cases it may be possible to apply the results of other studies of similar areas to the wetland under consideration (Georgiou *et al.* 1997, Barbier *et al*. 1997). This is called 'benefits transfer' because the measured benefits are 'transferred' from a site where a study has been carried out. It is then assumed that the existing or adjusted estimate of economic value can be used as an approximation of the economic value of the good or service in question. There are two main advantages of this approach: firstly, economic benefits can be obtained more quickly than by undertaking primary research, and secondly, it is considerably cheaper. However, extreme caution should be applied in resorting to this 'technique'.

There are three approaches to benefits transfer (OECD 1994, Georgiou *et al*. 1997):

a. *Transferring mean unit values*
Here it is assumed that the wellbeing experienced due to an environmental good or service at one site is the same as the next. The problem is that at the new site, individuals may not have the same preferences.

b. *Transferring adjusted unit values*
The mean unit values obtained at a different site can be adjusted for any biases that are thought to exist, or in order to better reflect the conditions at the new site. Potential differences that should be considered are differences in socio-economic characteristics of individuals, differences in the environmental change being examined, and differences in the availability of substitute goods and services.

c. *Transferring the demand function*
Instead of transferring adjusted or unadjusted unit values, the entire demand function estimated at existing sites could be transferred to the new site. More information is carried over to the new site using this function (OECD 1994).

2.6 THE APPLICABILITY OF THESE METHODS IN WETLANDS AND DEVELOPING-COUNTRY CONTEXT

Valuation techniques are extensively applied in developing economies, despite the fact that this application is very recent and has not been thoroughly researched (Georgiou *et al*. 1997). Thus it is not surprising that many problems have been identified which have not yet been adequately resolved. These commonly referenced problems, as well as problems experienced during this study, include:

1. Many developing economies distort market prices through price fixing or other regulatory activities.
2. Basic data on physical outputs, e.g. fisheries data, is often hard to come by, because it is collected irregularly or unreliably, if at all. Where data is available, it is often stored in a very unprocessed state.
3. Information sources may be biased or conflicting in areas where political and traditional or minority groups do not see eye-to-eye, as is the case in many rural African areas.
4. Inadequate data sources are further exacerbated by difficulty in new data collection. Villages are often remote and access can be difficult and time-consuming or expensive. Due to lack of formal education, and hence a poor understanding of this type of research, rural respondents may often be reluctant to divulge quantitative data to outside researchers. Part of the reason for this may be their reluctance to provide information or opinions when this is the realm of their superiors in the tribal system.
5. Lack of ownership or control of resources may make it difficult for respondents to express willingness to pay in contingent valuation surveys.
6. Gender inequality is an integral part of rural African society. Because of the inferior status of women, their contribution to surveys is very limited. This is a particular problem in the quantification of resource use for resources that are mainly collected by women.
7. Difficulties in gathering survey data may be further exacerbated in some cases by 'survey fatigue', especially in areas where several government and non-government organisations have been active.
8. Cultural differences also hamper the use of hypothetical market surveys. People in rural African communities are not accustomed to handling "what-if" scenarios and are unlikely to provide appropriate answers to such questions. This makes contingent valuation methods or questions about substitution particularly challenging.
9. Cultural differences about the concepts of conservation and development, lead to misunderstanding of research agendas and also hamper the collection of appropriate data.
10. Any surveys in which people are asked to express value in monetary terms is potentially subject to problems when applied in subsistence societies or any communities where money is not the predominant medium of exchange. These problems may be overcome to some extent by research into the barter-exchange value of goods, as discussed above.
11. Lack of markets for communally-owned or state land precludes the use of hedonic pricing methods, which rely on well-functioning property markets.

2.7 ISSUES OF SCALE, TIME AND DISCOUNTING IN THE CALCULATION OF PRESENT VALUE

2.7.1 The choice and effects of scale

2.7.1.1 Scale of values

There are no limits to the spatial extent to which some costs and benefits associated with wetlands could be felt and it is thus important to be explicit about the scale at which benefits and costs are being considered and compared in order to answer the question: "value to whom?". Costs and benefits can be considered at a local, national, regional and global scale. Local-scale benefits may incur regional-scale costs, and vice versa. Whereas national, and even global, 'communities' are relatively easy to define, it is more difficult to define the geographical and social limits of the local communities associated with wetlands. Local communities thus have to be defined on the basis of explicitly-stated criteria.

2.7.1.2 Scale effects in estimating changes in value associated with policy changes

The values obtained using the methods described in this section can be used to provide an estimate of the total value of wetlands under the existing system of land use, management and general policy framework. Depending on the scale of possible changes associated with a change in policy, these values may not always be directly applicable for estimating the resultant change in value of a wetland. The methods outlined above are appropriate as long as the scale of change is small enough that prices do not change significantly as a result of changes in wetland use. When the scale of change is large enough to affect prices, then a more complicated general equilibrium approach may be required.

2.7.2 Present value and discounting

Valuation above has referred to the flows of goods and services from wetlands (Table 2.2). In most cases the methods are applied to arrive at the annual values of these goods and services. However, the ultimate aim is to put a value on the wetland itself, not its annual productivity. The wetland comprises stocks of resources from which these flows are derived.

The value of the wetland is the present value of the flow of goods and services from the present until some specified time in the future. In calculating present value, two decisions have to be made:
(1) the time frame of the analysis
(2) the relative weighting of future and present values, determined by the choice of discount rate.

The time frame of analyses is usually in the region of 10 to 50 years. While longer time frames are of more interest to ecologists, shorter time frames are more commonly used because the lifespan of policy is usually relatively short, and because of the effect of discounting on future values. Under most circumstances, values accruing beyond 20 years into the future are rendered negligible in present terms by discounting.

The discount rate converts future values to present values and its magnitude determines how future values are weighted relative to present values. The net present value of future net benefits is determined by the discount rate as follows:

$$NPV = \sum \frac{(B_t - C_t)}{(1 + r)^t}$$

where B_t and C_t are benefits and costs at time t and r is the rate of discount.

A zero discount rate would mean that values accruing far into the future will have the same value in present terms as values accruing at present. Thus the net present value of a stream of net benefits would be equal to the sum of the net benefits in each year into the future. An infinite time horizon would thus yield infinite value. High rates of discounting, on the other hand mean that future values are not worth much at all, and values accruing in the near future are far more important.

Discount rates can be related to interest rates. For example, if capital grows at a real interest rate of 10%, then in theory, the investor should be indifferent between receiving an amount of US$100 in the present or US$110 in a year's time. Similarly, the present value of a next year's earnings of US$110 will be US$100, calculated by applying a discount rate of 10%. The discount rate can thus be based on the real rate of earning interest on investment accounts or the interest costs of borrowing capital. Discount rates based on these interest rates can be considered to be 'private' discount rates in that they reflect individual rates of time preference. In reality, private discount rates will be higher than this when the risk of poverty, starvation or death is high. Social discount rates are considered to be far lower than private rates, because society as a whole places greater value benefits and costs to future generations than individuals do. While there is no interest rate proxy for a social discount rate, the conservationist argument is that a low, or social discount rate should be applied when valuing environmental costs and benefits.

2.7.2.1 The influence of non-sustainable use on wetlands values

Most valuation studies implicitly assume that the resources are used both sustainably and optimally. In converting annual benefit streams to net present values, it is simplest to assume that the magnitude of the benefit stream will be maintained for the duration of the time frame of the analysis. This carries the implicit assumption that resource use and other productive activities are sustainable and that their levels are optimal. However, resources may be sustainably under-utilised. The implications of these assumptions and the effect of their relaxation is shown in Fig. 2.2.

With a zero discount rate, the present values of the benefit streams in Fig. 2.2 would be ranked as follows: NPV (a) > NPV (b) > NPV (c) > NPV (d). Thus the most optimal and sustainable use path (a) yields the highest value. If resources are under-utilised (path b) or have been mined to low output levels by past overutilization (path d), then the valuation exercise is in danger of underestimating the value of the wetland. If on the other hand, resources use is assessed at a time when resources are being overutilised at levels above the maximum sustainable yield (path c), then the exercise will result in an overestimation of the wetland's value. To some extent, the effects of over- or under-utilisation may also be reflected in relatively high and low prices and harvesting costs respectively. It is interesting to note that, even if the future path of the net benefits of resource use were known, a high discount rate would tend to favour the overutilization of resources. Thus, beyond a certain discount rate, the present value of path (c) will be higher than the present value of the sustainable path (a), because future benefits in path (a) will be worth very little to the present generation.

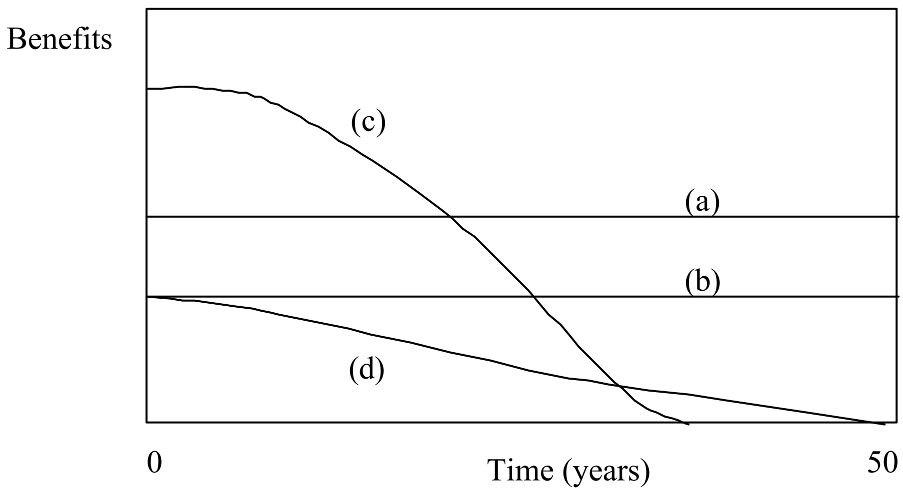


Figure 2.2. Hypothetical, undiscounted benefit stream from a flow of consumptive use of natural resources under base-year conditions of (a) optimal sustainable use, (b) sustained underutilization, (c) early-stage overexploitation and (d) long-term overexploitation.

Thus, in wetland valuation studies it is imperative that the level of use in relation to optimal sustainable yields is investigated in order to produce a valid interpretation of the results of the valuation methods applied, and a realistic estimate of net present value. The determination of optimal yields requires detailed biological information on the dynamics of resource availability as well as use.

2.7.2.2 Static vs dynamic modelling

Economic models can achieve varying levels of complexity. Three levels of complexity are described below:

(a) Static models
These are characterised by the assumption that current levels of use are sustainable and optimal, as described above. Most wetlands valuations make this assumption, mainly due to data constraints, although allowances are sometimes made for overexploitation by lowering estimates of sustainable annual values from those found through household surveys.

(b) Single-use dynamic models
These adjust for the fact that the resource may not be currently harvested optimally. If, for example, fishery harvests could be three times the current use, then values should reflect that. A dynamic analysis would, as suggested above, ideally require more detailed biological information relating to resource stocks and their production rates. Where information is limiting, however, it is possible to incorporate a factored adjustment to compensate for over- or under-exploitation, based on analyses of historical use trends, price trends, household surveys (where respondents reflect on trends in harvesting effort) as well as scientific inventories and stock assessments.

(c) Multiple-use dynamic models
This is the analytically correct approach in a 'second-best' world where some uses are managed optimally and others are managed sub-optimally. Such a model incorporates linkages between different production systems and seeks to solve a dynamic optimisation problem across multiple uses.

3 STUDY AREAS

3.1 DEFINING THE WETLANDS AND STUDY AREAS

This study concentrates on the same four wetland areas within the Zambezi River Basin as being used as field subproject areas by the overall ZBWCRUP project:

1. the Barotse wetlands;
2. the eastern Caprivi wetlands;
3. the lower Shire wetlands; and
4. the Zambezi Delta.

The positions of these wetlands within the basin are shown in Fig. 3.1. For the purpose of this study it was necessary to define the study areas in some detail.

The definition of wetlands adopted by the Ramsar Convention on Wetlands of International Importance is “areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water, the depth of which at low tide does not exceed six metres” (Article 1.1), and they “may incorporate riparian and coastal zones adjacent to the wetlands, and islands or bodies of marine water deeper than six metres at low tide lying within the wetlands” (Article 2.1). This definition is rather broad, and thus not particularly useful in delineating the wetlands in the four case study areas. The ZBWCRUP biodiversity study (Timberlake 1997) adopted Breen's (1991) definition, in turn adapted from that used by the US Fish and Wildlife Service, as: "land where an excess of water is the dominant factor determining the nature of soil development and the types of animal and plant communities living at the soil surface. It spans a continuum of environments where terrestrial and aquatic systems intergrade." This definition implies the area that would be significantly affected, e.g. in terms of vegetation cover, by a reduction in water flow. The latter definition is stricter in that it would exclude, for example, the raised woodland areas that occur within a wetland area. In this study, the word 'wetland' is used in the stricter sense given above, and include riverine floodplains, palustrine wetlands - where there is more or less permanent water, e.g. papyrus swamp, marshes, mangroves and estuaries. The word 'study area' denotes more than this, as discussed below.

In order to make quantitative estimates of value, the economics study requires a more rigorous definition of boundaries than the biodiversity study, in which boundaries were not really defined in terms of actual area. It is one thing to define the boundaries of the wetland but it is another thing to define the boundaries of the community which benefits from the wetland. It is particularly problematic to define the study area *a priori* for an economics study of this nature, because it is difficult to know in advance the geographical limits of the immediate benefits of the wetland under consideration. For example, people living several kilometres from the wetland may depend on the wetland for harvesting certain resources or for grazing their cattle, while people even hundreds of kilometres distant may utilise wetland resources in some way. Similarly, wildlife populations may make use of both wetlands and the surrounding areas. Thus the 'wetland' area is the area for which we attempt to value the flow of goods and services and the 'study area' is represented by the limits of the community which receives most of the immediate benefits from the wetland. The study area thus necessarily considers all land within the wetland as well as to some extent around the wetland in terms of its population and other resources.

The study areas chosen for the ZBWCRUP project (Hiscock *et al*. 1996), and roughly defined in the ZBWCRUP Biodiversity Study (Timberlake 1997), vary in the extent to which they include or exclude primary and inter-linking areas of the major wetlands. The size and boundaries of the study areas have been variously defined in the different biodiversity, social and management studies associated with each of the four areas. In this study we attempt to define the wetland areas based on well defined ecological as well as social criteria, but our boundaries are limited in some cases by information constraints.

Wetland values are discussed as far as possible at three levels: local, national and regional levels. The local area refers to values accruing to the population within the study area, the national level refers to the values accruing to the country or countries within which each study area falls, and the regional level refers to values accruing at the scale of the entire Zambezi Basin.

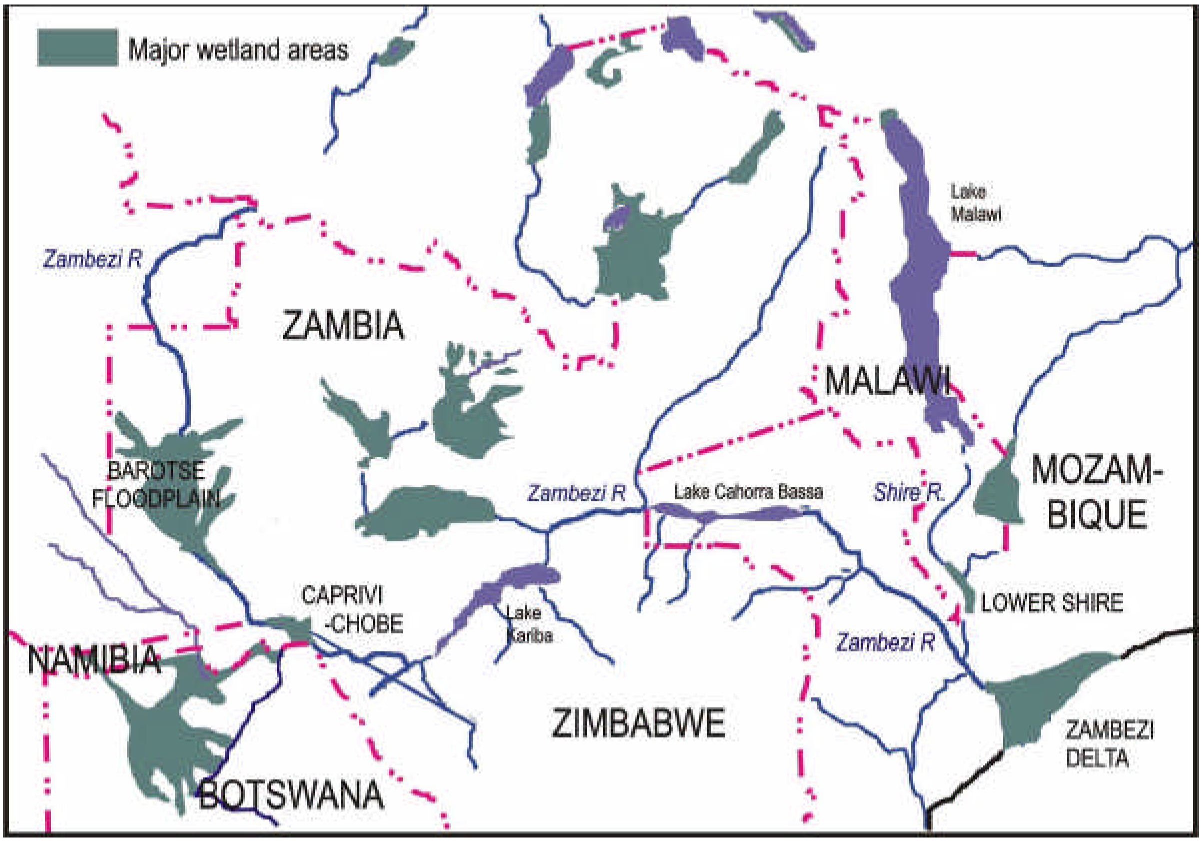


Figure 3.1 Wetlands of the Zambezi Basin, showing the four areas considered in this study

3.2 THE BAROTSE FLOODPLAIN

The Zambezi rises in north-western Zambia. After passing southward through Angola into Zambia's Western Province, the river becomes larger and more consolidated, giving rise to a series of floodplains which flood annually (Timberlake 1997). These include the Barotse Floodplain and other interconnected areas. Together they form a broad wetland area which becomes narrower towards the south, just south of Senanga, where the river turns south east (Fig. 3.2).

3.2.1 Extent of the study area

The extent of the floodplains in Barotseland is difficult to determine, because the area is flat and open, floodplain grades into dambo, annually flooded areas grade into rarely flooded areas and it is difficult to separate the wetlands influenced by the Zambezi from those fed by other river catchments (Timberlake 1997). The biodiversity study (Timberlake 1997) considers the wetland area to extend from Lukulu to just below Senanga (Fig. 3.2), including the Liuwa Plain National Park, the Luena Flats, the Barotse Floodplain and the wetlands associated with Lungwebungu river.

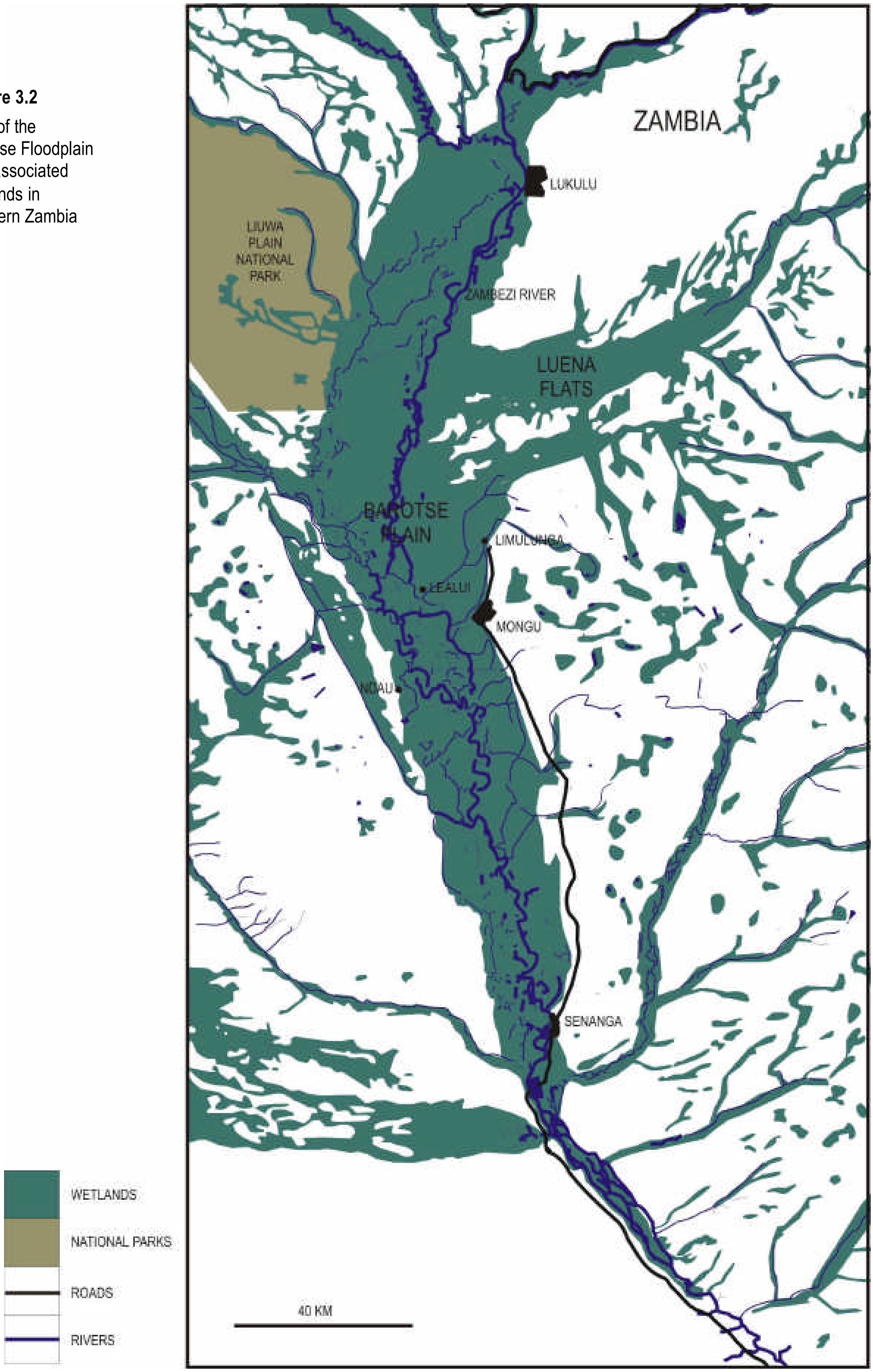
The area of the floodplain is not determined in the biodiversity study. However, it is necessary to define limits of the wetland and study area in the valuation study. Based on government 1:250 000 maps, the area of the Barotse floodplain is in the region of 550 000 ha. This is similar to the estimate by Verboom & Brunt (1970) of over 500 000 ha. Around this wetland, the Lungwebungu wetlands cover approximately 70 000 ha, the Luena Flats cover 110 000 ha, and wetland arm associated with the Luanginga River to the south of Liuwa Plain National Park covers at least 100 000 ha. The Liuwa Plains National Park covers 366 000ha (Muleta *et al*. 1996). Thus wetlands in this region are extensive, covering approximately 1.2 million ha. In this study, we consider only the Barotse floodplain itself (550 000 ha). The study area, from which we determine population size, comprises people living within this area and around the margin (see below).

3.2.2 Biophysical characteristics

The floodplain mainly comprises extensive grasslands rather than swamps. Trees are largely absent from the seasonally flooded areas but occasional raised wooded areas, many of which are anthropogenic, of 1-2 ha in extent occur throughout the floodplain (Timberlake 1997). The latter are also known as 'termitaria' (Timberlake 1997), 'floodplain mounds' or '*mazulu*' (van Gils 1988), and are often the site of seasonal settlements. Vegetation types of conservation interest include Floodplain Grasslands with *Echinochloa* sp. and *Oryza* sp. and Wet Pan Grassland with Mixed Species (Jeans & Baars 1991, Timberlake 1997). Seepage wetland, found in the large tributaries of the Zambezi, is under threat from commercial rice production (Timberlake 1997). Nutrient rich springs (*mataba*) of biodiversity interest at the foot of the escarpment near Mongu have mostly been cultivated for vegetables. Swamp forests (*butoya*), dominated by water-dependent *Syzygium* spp., are scattered throughout the

Figure 3.2

Map of the Barotse Floodplain and associated wetlands in Western Zambia



Barotse floodplains. These areas, which are of conservation importance, are threatened by demand for wood (Timberlake 1997). The Luena flats contain grasslands dominated by *Echinochloa pyramidalis*, *Trachypogon spicatus* and *Eragrostis* spp. (Jeanes & Baars 1991), and higher plain areas within the Luena flats support an unusual *Borassus aethiopum* palm and *Acacia* savanna landscape.

The animal diversity of the Barotse floodplains is not well known, and its importance is thus difficult to gauge. However, it is thought to be a centre of diversity due to its age and stability. The floodplain area appears to be an important area for wetland birds and various reptiles and amphibians, and it is also important for lechwe *Kobus leche*, particularly in the upper Barotse floodplains (Timberlake 1997).

No quantitative breakdown of the habitat areas within the Barotse floodplain is available. Central Barotse is defined as one of the ten land systems within the Western Province, and is described as grassland, with 25-50% wetland (van Gils 1988). Based on field visits, we consider the habitat breakdown to be roughly as follows:

- Palm savanna: 2% (11 000 ha);
- Floodplain grassland: 40% (220 000 ha);
- Wet grass: 40% (220 000 ha);
- Reeds and sedges: 10% (55 000 ha); and,
- River channel: 8% (44 000 ha).

The floodplain is flanked by plateaux of Kalahari sand covered in semi-evergreen woodland containing economically important timber species such as *Baikiaea plurijuga* and *Pterocarpus angolensis*, and interspersed with low-lying dambos which are characterised by grassland vegetation (Timberlake 1997). The Liuwa Plain National Park and surrounding areas to the west and north-west of the Barotse floodplain are relatively flat, and are waterlogged in the rainy season and are extremely dry during the rest of the year (Simwinji 1997).

Three climatic seasons can be distinguished in the Barotseland area (van Gils 1988):

- Apr-Sep: dry and cool nights.
- Oct-Dec: dry and hot weather
- Nov-Mar: rainy season, peaking in Dec-Feb.

Rainfall decreases from about 1021mm in the north to 730 mm in the south. The wet and dry seasons and periodicity of flooding are illustrated in Fig. 3.3. The onset of flooding varies enormously, and may occur between December and March. The maximum flood level occurs in about April. The degree of flooding does not correspond to the amount of rainfall in the area, however, but depends on what happens in the upper catchment areas and on seepage from the uplands (Simwinji 1997). The length of the flooded period appears to be a major determinant of ecological conditions and characteristics in the Barotse floodplain (Timberlake 1997). Flooding starts earlier in the north than in the south (Ottens 1995 in Simwinji 1997).

Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Wet season				Dry season							
	Flood begins						Abatement				
	Average flooded period										

Figure 3.3. Wet and dry seasons of the Barotse Floodplain, earliest and latest periods of flooding and abatement and the average flooded period from average time of flooding to average time of abatement (adapted from van Gils 1988).

3.2.3 Socio-economic environment

3.2.3.1 Social organisation, political structure and institutions

The study area falls under a dual administration: the Barotse Royal Establishment and the Central Government.

The study area falls within the traditional kingdom of Barotseland. The Barotse floodplain is dominated by the Lozi people, who are also referred to as the 'plains or water people'. The Barotse Royal Establishment is headed by the King, or *Litunga*, who is a Lozi, and, secondarily, by princesses who are also members of the Royal Family. The Litunga rules through chiefs, called *Indunas*. In addition, the traditional Prime Minister or *Ngambela*, who is not part of the royal family, oversees traditional administration. Administration is carried out at the regional level by traditional ministers and at the *silalo*, or village group, and village level by the *Silalo Indunas* and *Indunas* respectively. The Provincial Government is headed by the Deputy Minister of Western Province, assisted by a Permanent Secretary, who in turn is supported by Provincial Heads of Departments. The latter are supported at the district level by the District Officers, and the District Secretary is the administrative head at this level (Simwinji 1997).

The Lozi culture and traditions are closely linked with the seasonal flooding of the Barotse plain, and most of the inhabitants of the wetland area move from the floodplain to the uplands and plain fringes during the flood period. This annual movement, which includes the movement of the *Litunga* in a highly-celebrated traditional ceremony, is called *Kuomboka* (Nkhata & Kalumiana 1997).

Land in rural areas cannot be privately owned and has traditionally been allocated by tribal authorities. The traditional land tenure system has continued despite the land act passed in 1975 which placed all land in Zambia under the president (Simwinji 1997). Under the traditional system, land, together with the rights of production, is held by families and is heritable.

3.2.3.2 Population

It is difficult to find reference to the size of the population of Barotseland, since the kingdom is no longer officially recognised, and censuses take place according to political boundaries. Zambia's Western Province comprises six administrative districts, and the study area falls into four of these districts: Kalabo, Lukulu, Mongu and Senanga. The population is concentrated along the floodplain and main towns. The urban population comprises about 10-16% of the total population of the four districts (Nkhata & Kalumiana 1997, Simwinji 1997). Nkhata & Kalumiana (1997) provide estimates of the size of the district populations in 1997, based on the 1990 census and population growth rates, and also illustrate the spatial distribution of the populations within these provinces. We base our 1999 population estimate for the study area on Nkhata & Kalumiana's (1997) estimate of the rural population living within and at the floodplain edge, accounting for an annual population growth of 2.8% (Table 3.1). Just over 600 000 people were recorded in Western Province during the 1990 census (Simwinji 1997).

Table 3.1. The 1997 population estimates in four districts of Western Zambia (Nkhata & Kalumiana 1997), the percentage of the population in each district falling within the study area (estimated graphically), and the total population estimate for the study area.

District	1997 population	Rural floodplain population 1997	Estimated study area population 1999
Kalabo	113 534	43 146	
Lukulu	61 207	38 493	
Mongu	156 822	50 549	
Senanga	161 923	79 312	
TOTAL		211 500	**223 510**

Mean size of households in our household survey was 8.1 people per household. This is far greater than the average of 4.6 people reported in Simwinji (1997), which was the lowest in the country. Based on our findings, we estimate that the study area contains approximately 27 600 households, although it could contain as many as 48 600. It is almost impossible to say how many of this total move between the wetland and the uplands, and how many permanently occupy the floodplain margins. The population that make use of the wetland for grazing extends beyond this area, thus including additional households (see livestock analysis).

Approximately 43% of the population is under 15 years old and the productive proportion of the population, aged between 15 and 49 years, makes up 35% of the total.

3.2.3.3 Economic activities

Agriculture is the most important activity in terms of subsistence food production, and maize is the most preferred staple crop, primarily for making maize-meal or *buhobe,* although this can also be made from millet or sorghum. Fishing is an important economic activity, both because fish is the traditional staple relish of the flood plain people (Nkhata & Kalumiana 1997) and as an important source of income (Timberlake 1997). Livestock are also important, especially as the traditional wealth of the Lozi (Nkhata & Kalumiana 1997). In addition, households are engaged in various cash-earning activities such as handicrafts, woven and carved, beer brewing from wild fruits or crops, the sale of fuelwood from the uplands on the plains and sales of agricultural products, especially milk and vegetables (Simwinji 1997). Products are marketed in Mongu's five markets, Kalabo, Senanga, Sesheke's two markets and Lukulu (D. Kabakwe, Dept of Fisheries, pers. comm.).

Less than 5% of the productive age group are in formal employment (Simwinji 1997), but there are no reliable data with which to calculate income per capita. The current minimum wage rate is ZK91 867 per month (US$65; D. Kamweneshe, *in litt.*). About 76% of the rural population in the province live in poverty, as defined by the Provincial Programme of Action on Poverty Reduction in Western Province (Simwinji 1997). Lean months are November to Jan/Feb when incomes are lowest and expenditures highest, and little food is available (Simwinji 1997).

3.2.4 Pressures on natural resources

The Barotse floodplain has been settled for centuries. Land use pressures, although intensifying, do not seem to have changed greatly in nature over this time period. The main threats to biodiversity in the Barotse floodplains have been identified as follows (Timberlake 1997):

- lower flood levels due to conditions in the upper catchment, the causes of which are not well understood, but may be due to human influence on rainfall or flow,
- increased clearance for agriculture, especially rice, due to increased human populations and government and donor funding and subsidies,
- increased livestock grazing pressures, partly due to increased wealth, aid and the control of tsetse fly and trypanosomiasis,
- increased incidence of fire, mainly for grazing,
- deforestation in floodplain and flanking woodlands, especially over the last 40 years, caused by overharvesting, commercial logging, charcoal manufacture and increased incidence of fire, and
- hunting, poaching and overfishing, especially since independence. A related problem is fish poisoning (Simwinji 1997)

For the near future, the potential environmental risks in the Western Province are expected to be in the overexploitation of renewable resources (van Gils 1988).

According to Simwinji (1997), natural resources were used sustainably under traditional management systems, but have been overexploited since powers were transferred to government institutions. The Lozi people are traditionally conservationists who used resources according to their customary laws based on indigenous knowledge systems. Now, few incentives exist for communities to be involved in natural resource management, and the main constraints are centred on legislation, tenure and ownership of resources (Simwinji 1997).

3.3 THE CHOBE-CAPRIVI WETLANDS

3.3.1 Extent of the study area

At Katima Mulilo the Zambezi turns markedly to the east and a series of broad floodplains are found where it forms the border between Namibia and Zambia up to Kazangula (Timberlake 1997; Fig. 3.4). The floodplain system in eastern Caprivi, lying to the east of the Kwando River, forms a vast, contiguous area of approximately 370 000 hectares, effectively linking the Kwando, Linyanti, Chobe and Zambezi Rivers, the four major rivers in the region (Mendelsohn & Roberts 1997; Paskin & Hoffmann 1995; Fig. 3.1). All these rivers can connect if water levels are high enough, and water from the Kwando could flow down the Linyanti, through Lake Liambezi which is currently dry, into the Chobe and finally into the Zambezi. Water can potentially flow in either direction depending on relative flood levels (Mendelsohn & Roberts 1997).

Like many borders in Africa, the boundaries of the Caprivi either follow the midstream of rivers, or run in straight lines, neither of which follows any environmental or cultural boundaries (Mendelsohn & Roberts 1997). Despite being interconnected, the floodplains of the eastern Caprivi are bisected by international boundaries and cross cultural and economic systems. None of the wetland area within eastern Caprivi or on the Zambian side falls within a formally protected area. On the Botswana side, a small amount of wetland falls within the Chobe National Park.

The exact area of the eastern Caprivi floodplain considered to be within the ZBWCRUP study region has not been defined by the Field Project Officer or the Biodiversity Assessment team. While acknowledging that the Linyanti and Kwando are linked to the Chobe-Caprivi wetlands to the east, they are essentially separate ecological and socio-economic systems, and this study focuses on the latter only, i.e. the far Eastern Caprivi wetlands (Fig. 3.4). The wetland area considered in this study lies predominantly within the Kabe constituency of the extreme eastern Caprivi, but is bounded by Botswana along the Chobe and also extends into Zambia (Fig. 3.4). The Kabe constituency (hereafter Kabe) is 211 600 ha in area (Mendelsohn & Roberts: GIS data). The study area in Zambia was defined as the area within a 3-5 km strip running around the outside margin of the wetland areas. The area was estimated at 93 000 ha from 1:250 000 ordinance survey maps (Surveyor-General 1985). The total area considered as the study area within the Chobe-Caprivi system is thus 304 600 ha. Within this defined area, the area of actual wetland is estimated to be 220 000 ha (from the 1: 250000 map, Surveyor-General 1985).

3.3.2 Biophysical characteristics

Topographically, the Caprivi is particularly flat without a single feature recognisable as a hill (Mendelsohn & Roberts, 1997). The floodplains of eastern Caprivi are the lower lying areas dominated by grasslands and old river channels at about 930 m above sea level, separated in

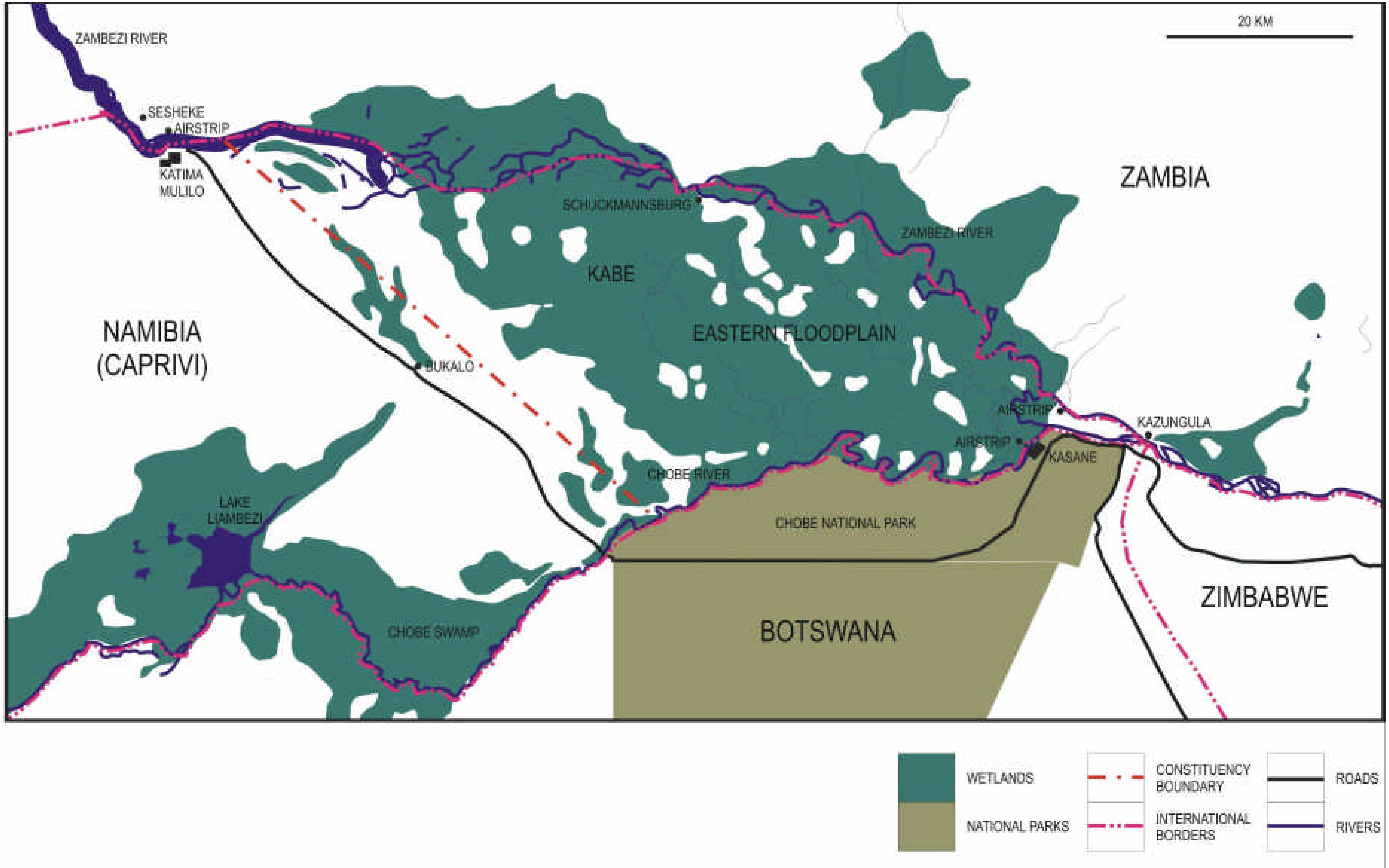


Figure 3.4 Map of the Chobe-Caprivi wetlands area

places by areas of riverine and mopane woodlands (Mendelsohn & Roberts 1997). The underlying soil-types are predominantly clay-loam with small areas of sandy clay-loam and organic clay (Mendelsohn & Roberts 1997). There are 32 species-defined vegetation types for eastern Caprivi, 14 of which are floodplain types (Timberlake 1997). Mendelsohn & Roberts (1997) give detailed vegetation descriptions for the various floodplain types. The open water channels are bounded by dense stands of many reed (e.g. *Phragmites australis*) and sedge (e.g. *Cyperus papyrus*) species, varying in size as the floodwaters rise and fall. Higher lying channels dry out regularly and the highly organic soils are extensively cultivated. The floodplain grasslands typically contain a mosaic of grasses (e.g. *Eragrostis* spp., *Hyparrhenia* spp., *Tristachya superba*) and slightly wetter soils are dominated by extensive lawns of *Cynodon dactylon* which form an important grazing resource for both wildlife and livestock. Trees along the rivers are tall and diverse in species composition and sandy areas are covered predominantly by *Terminalia sericea* woodlands (Mendelsohn & Roberts 1997).

Kabe is dominated by floodplain vegetation types, comprising about 90% of its area: Zambezi floodplain channels, Zambezi floodplain grassland, Zambezi transition grassland, Zambezi woodland, Chobe wetland and Chobe swamp grassland, with the remainder comprising Mopane woodland near Katima Mulilo (Mendelsohn & Roberts 1997).

We consider the original habitat breakdown of the 220 000 ha of wetland to be roughly as follows:

- Palm savanna: 2% (4 400 ha)
- Floodplain grass: 70% (154 000 ha)
- Wet grass: 15% (33 000 ha)
- Reeds & papyrus: 8% (17 600 ha)
- Channel: 5% (11 000 ha)

The relative abundance of water sets the Caprivi apart from the rest of semi-arid Namibia (Mendelsohn & Roberts 1997). Average annual rainfall decreases from about 750mm in the north-east of eastern Caprivi to about 500mm in the south-west. The wet and dry seasons and periodicity of flooding are illustrated in Figure 3.5. The onset of flooding varies enormously, and may occur between February and April. The maximum flood level occurs in late April or early May. The degree of flooding does not correspond to the amount of rainfall in the area, but depends on what happens in the upper catchment areas (western Zambia and Angola) and flooding is often delayed until after abundant summer rains have fallen in these areas (Mendelsohn & Roberts 1997).

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
Wet season							Dry season				
				Flood begins			Abatement				
					Average flooded period						

Figure 3.5. Wet and dry seasons of the eastern Caprivi floodplains, earliest and latest periods of flooding and abatement and the average flooded period from average time of flooding to average time of abatement (adapted from Mendelsohn & Roberts 1997).

3.3.3 Socio-economic environment

3.3.3.1 Social organisation & political structure, institutions

Land in the Caprivi region is under either State or communal administration. The Kabe constituency is comprised of entirely communal lands under the jurisdiction of the traditional authorities, but with services being provided by local government.

Regional government is headed by an elected Governor and local government is represented by elected councillors, of which there are six, one for each constituency in the Caprivi (Mendelsohn & Roberts 1997). Kabe is the most eastern constituency in the Caprivi. Katima Mulilo on the north-western boundary of the Kabe constituency is Caprivi's capital and administrative centre (Fig. 3.4). Regional and local government is responsible for the provision of health services, education facilities, utilities, infrastructure and agricultural services.

The floodplain is occupied by Lozi people belonging to the Subia and Mafwe tribes, but predominantly the former. There are several levels of traditional authority in eastern Caprivi's communal areas. The most senior male member of each village is the headman, and several villages are represented by a senior headman who is advised by the village headmen. Senior headmen act as local representatives on the tribal council (*kuta*) which is presided over by the *ngambela* (chief councillor) who is appointed by the tribal head or chief. The *ngambela* communicates the wishes of the chief to the tribe through this traditional structure, and *vice versa* (Mendelsohn & Roberts 1997).

The settlement of Bukalo lies just on the western boundary of the Kabe constituency (Fig. 3.4) and the Bukalo *kuta* is the traditional authority for the entire constituency (i.e. the highest legislative, administrative and judicial body in the district; Mendelsohn & Roberts 1997). Land in Caprivi's communal areas cannot be privately owned and is allocated by the tribe's traditional authority. Each man in Kabe pays four Namibian dollars per annum to the Bukalo *kuta* for the right to live on and use a piece of land (*kuta* senior headman: pers. comm.). Under customary law, this 'right to avail', or right to make use of the land and natural resources available to the community, requires maintaining some sort of permanent presence on communal lands (Ashley & LaFranchi, 1997). Some administrative decisions are centralised, e.g. the Bukalo *kuta* prohibits burning for pasturage, while others are delegated to the village headmen, e.g. each headman controls the grazing rights around his village (*Kuta* senior headman, pers. comm.).

3.3.3.2 Population size and distribution

Mendelsohn & Roberts (1997) provide a population figure for Kabe of 16991, estimated from 3023 households (determined by aerial photography) with an average of 5.6 people per household. This compares favourably with previously reported figures ranging from 4.8 to 6.1 people per household (Mendelsohn & Roberts 1997, Ashley & LaFranchi 1997). This study found an average of 6.5 people per household for Kabe. Adjusting Mendelsohn & Roberts' household estimate to 1999 figures (3% growth rate, SADC 1999a), the population for Kabe is estimated to be 20 846. No detailed population statistics were available for the Zambian section of the floodplain adjacent to much of Kabe. Some estimates of population density were available for the three wards of Sesheke District that lie to the north of the western section of Kabe (Maondo, Simungoma and Mabumbu). The weighted mean of these population density estimates, adjusted to 1999 figures, was 11.35 people per kilometre squared (CSO 1990). This is similar to the mean population density estimated in Kabe of 9.9 people per kilometre squared. It was decided to simply apply the same population density on the Kabe floodplains to the area estimated in Zambia, giving a population estimate for the Zambian portion of the study area of 9 102. The adjacent Chobe wetlands on the Botswana side of the border lie within the Chobe National Park and are officially uninhabited. The total population for the entire study area is thus estimated at 29 948.

Most households are distributed over wide areas on the floodplains themselves; some are in the woodland areas immediately adjacent to the floodplains (Mendelsohn & Roberts 1997, Ashley & LaFranchi 1997). All permanent structures are constructed on higher ground, which is not inundated during normal flood years. Usually, several households are grouped together to form a village, but it is not uncommon for a single household to form a small isolated settlement of only a few structures. Almost all households utilise the wetland areas in their immediate vicinity for their various livelihood strategies (*kuta* senior headmen: pers. comm.).

Many villages are also situated along the main road between Katima Mulilo and Ngoma, just outside of the study area. The extent to which these people use floodplain resources is unknown. It is also worth noting here that the town of Katima Mulilo, which lies a few kilometres from the north-western boundary of the Kabe constituency, contains a total of between 2655 and 4202 households (Mendelsohn & Roberts 1997, Ashley & LaFranchi 1997). This significant population centre has an unknown effect on the various wetland values calculated below and was explicitly ignored for this reason, despite the fact that wetlands products were in obvious use.

3.3.3.3 Economic activities

Of all economic and livelihood activities in Caprivi, agriculture is the most important. People spend more time farming than in any other economic activity and it provides them with most of their food, income and security (Paskin & Hoffmann 1995, Ashley & LaFranchi 1997, Mendelsohn & Roberts, 1997).

Stock farming is dominated by cattle which are valued for draught power, food products, cash and for storing wealth (Paskin & Hoffmann 1995, Ashley & LaFranchi 1997). The three main staple grain crops grown in the Caprivi region are millet, sorghum and maize (47%, 27% and 26% of fields planted respectively during 1994/95) along with legumes and other vegetables (Mendelsohn & Roberts, 1997, Ashley & LaFranchi, 1997). Fishing is both an important subsistence and a commercial activity, and most floodplain households rely on fish as their primary source of protein (Tvedten *et al.* 1994, Ashley & LaFranchi 1997, *kuta* senior headmen: pers. comm.). Wages and pensions provide regular cash incomes for 15-20% of rural households (Ashley & LaFranchi 1997). In addition, many households are engaged in various cash-earning activities such as the sale of thatch and reeds, beer brewing from crops, collection and sale of fuelwood and poles from the uplands; sale of agricultural products (especially milk, vegetables and maize) and sale of woven and carved handicrafts (Ashley & LaFranchi 1997).

The dependence on agriculture and wild natural resources in Kabe is probably more intense due to a predominance of poorer rural households and access to relatively fertile soils and large amounts of moderate to good grazing (Ashley & LaFranchi 1997, Mendelsohn & Roberts 1997, pers. obs.).

3.3.4 Pressures on natural resources

The eastern Caprivi floodplains have been settled since before the 1600s and prior to the First Lozi Empire (Mendelsohn & Roberts 1997). Since then, human populations have increased by an order of magnitude and direct human pressure is beginning to take its toll. The main threats to biodiversity in the eastern Caprivi floodplains have been identified as follows (Timberlake 1997):

- lower flood levels, possibly due to increased human abstraction in the upper catchment;
- increased clearance for agriculture, due to increased human populations and government and donor inputs;
- water resources development projects in the arid Botswana and Namibia;
- increased livestock grazing pressures, partly due to increased wealth, aid and the control of tsetse fly;
- increased incidence of fire, mainly for grazing;
- deforestation in floodplain and flanking woodlands, caused by overharvesting and the increased incidence of fire;
- hunting and poaching, much of which occurred during the South African occupation in the 1980s;
- overfishing due to pure population pressures and protein needs; and
- extensive ecological damage to riverine woodlands on the Chobe side, caused by elephants.

3.4 THE LOWER SHIRE WETLANDS

3.4.1 Extent of the study area

The Lower Shire valley extends from Kapuchira falls in the north, near Blantyre, to where the Shire River, after flowing through western Moçambique, meets the Zambezi near Caia (Timberlake 1997; Fig. 3.6). The two major wetlands in the valley are Elephant Marsh and Ndinde Marsh, with almost 50% of Ndinde Marsh being in Moçambique.

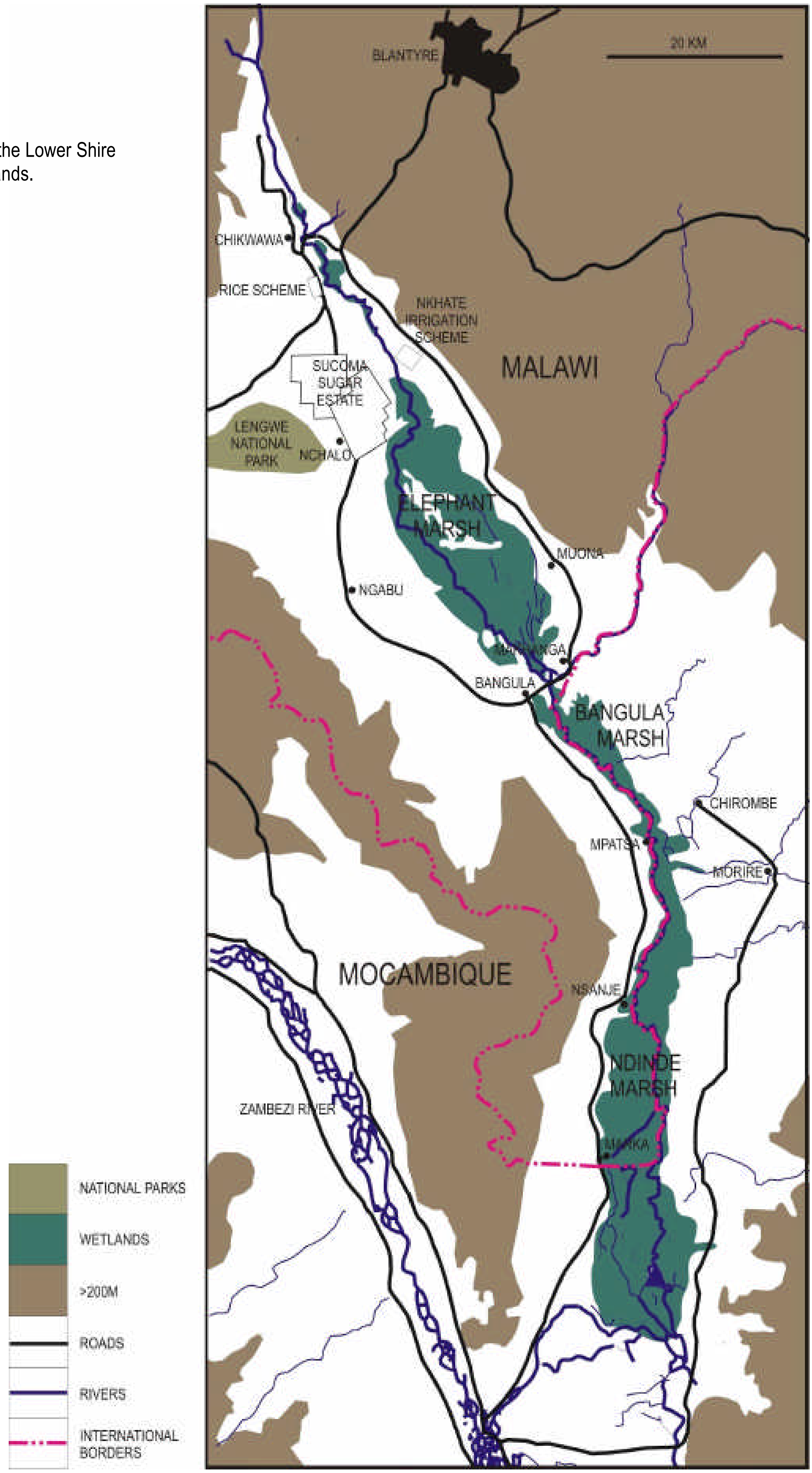
The area of the Lower Shire wetlands was not precisely defined by the IUCN biodiversity assessment team during their Phase I study, or by the Field Project Officer. The total area of the two districts, Chikwawa and Nsanje, that cover the Lower Shire valley in Malawi is 669 770 ha (NSO 1987). The floor of the Lower Shire valley forms a broad plain that terminates abruptly against the escarpment along the eastern side of Elephant Marsh and rises gently towards the western escarpment, terminating in a series of hills west of Elephant Marsh. Further south, this plain terminates again quite abruptly against the escarpment west of Ndinde Marsh, but continues on the eastern side of the Marsh for a considerable distance into Moçambique (Fig. 3.6, pers. obs.). The area of this broad plain that is subject to infrequent peak flooding (e.g. 1997 flood) is limited to land lying below the 200m contour line (Fig. 3.6; F. Kalewekamo, F.P.O.; pers. comm.). In Malawi, this comprises 35-40% of the Chikwawa and Nsanje districts, or about 250 000 ha (estimated from 1:250 000 ordinance survey maps, Dept of Surveys 1992).

The area on this floodplain that we consider to be the study area in Malawi is defined by a series of roads and natural features that form the most likely limits from within which local households will access wetland resources. The western boundary of the study area is taken as the Marka-Chikwawa road as far north as Ndalanda, except where this road swings away from Elephant Marsh around Ngabu, at which point the 100m contour (running 5-8km from the Marsh) is briefly used (Fig. 3.6). The eastern boundary of the study area is taken as the 200m contour line from Ndalanda in the north to Muona in the south (1-6 km from the Marsh), and then the Muona-Makhanga road to the Moçambique border (Fig. 3.6). On the Moçambican side, the study area was defined by estimating the area within a 3-5 km strip down the eastern side of Bangula Marsh, and surrounding Ndinde Marsh. Thus, the total area within this defined study area was estimated at 243 000 ha (Dept of Surveys 1992), of which 183 000 ha lie in Malawi and 60 000 ha lie in Moçambique.

The area of actual wetland in the Lower Shire valley, calculated from ordinance survey country maps (Dept of Surveys 1992), is 162 000 ha. This area comprises:

- Elephant Marsh, 60 000 ha from the north eastern border of the ILLOVO estate to the bridge at Chiromo;
- Bangula Marsh, 17 000 ha from the Chiromo bridge to Mpatsa;
- Ndinde Marsh, 80 000 ha from Mpatsa southwards across the Moçambican border until the Ziu Ziu River leaves the Shire River westwards towards the Zambezi River; and,
- 5 000 ha of marshland north of Elephant Marsh and along tributaries.

Figure 3.6. Map of the Lower Shire study area and wetlands.



3.4.2 Biophysical characteristics

Much of the water in the Shire River is overflow from lake Malawi, which is part of the Great East African Rift Valley (Timberlake 1997). Water levels in the lake have fluctuated greatly during the past million years due to climatic fluctuations, and there is evidence to suggest that as early as 150 years ago, the lake was about 120m lower than at present (Timberlake 1997). During periods of low lake levels, it is likely that the wetlands of the Lower Shire were significantly smaller than at present, or non-existent (Timberlake 1997). Water levels in Lake Malawi are reportedly declining at present, and the water levels of the main marsh in the valley have dropped to levels below the historical average (Timberlake 1997).

The importance of Elephant Marsh may have been recognised as early as 100 years ago when it was declared as one of Malawi's first Game Reserves in 1897. However, game regulations were little enforced and Elephant Marsh was degazetted in 1922 (Timberlake 1997). Today, only a small amount of marginal wetland habitat can be considered protected in the Lower Shire valley by the Lengwe National Park adjacent to Elephant Marsh, and Majete Game Reserve in the north (Timberlake 1997). In addition to the considerable fluctuations in water levels, the marshes have been subjected to extensive human cultivation during the last 150 years (Timberlake 1997). Given this historical intensity in land-use and variability in flow, the Biodiversity assessment team is unsure as to whether the wetland of the Lower Shire is still an ecologically functioning entity (Timberlake 1997). Ndinde Marsh appears to be more ecologically and biologically intact than the rest of the adjacent wetlands (Timberlake 1997, pers. obs.).

The wetland and marsh areas are characterised by flowing channels, flooded backwaters, pools, grasses, reeds and sedges, with extensive areas of the slightly drier soils cultivated with cereal crops, sugar and vegetables. Maize cultivation is particularly prevalent on Elephant Marsh. Many of the backwaters and stagnant pools are planted with rice as water levels fall (Village surveys, FPO pers. comm., pers. obs.). The ILLOVO sugar estate currently has 11 000 ha of what used to be part of Elephant Marsh under commercial sugar (Fig. 3.6; R.C. Apsey, ILLOVO, pers. comm.). The broader floodplain is characterised by grassland, interspersed with woodland and dryland agriculture such as maize, millet and cassava (pers. obs.).

We consider the original habitat breakdown of the 162 000 ha wetland to be as follows:

- Palm savanna: 2% (3 240 ha);
- Floodplain grass: 20% (32 400 ha);
- Wet grass: 45% (72 900 ha);
- Reeds & papyrus: 27% (43 740 ha);
- Channel: 6% (9 720 ha).

The Lower Shire valley and its immediate catchment receives summer rainfall, with an average annual rainfall of over 1000 mm in the south, decreasing to about 750 mm in the north (SADC 1999b). The wet and dry seasons and periodicity of flooding are illustrated in Fig. 3.7. The onset of flooding varies, but usually occurs in February. Flood waters rise quickly and the maximum flood level occurs in March or April. The degree of flooding corresponds to the amount of rainfall in the catchment area, but also depends on what happens in the upper catchment areas that affect overflow from Lake Malawi, and on the flooding regime of the Zambezi River. During periods of high runoff corresponding with Zambezi flooding, the Shire River backs up from the Zambezi River to north of Elephant Marsh and floodwaters spread widely throughout the area (Timberlake 1997).

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
	Wet season						Dry season				
			Flood begins				Abatement				
				Ave flooded period							

Figure 3.7. Wet and dry seasons of the Lower Shire wetlands, earliest and latest periods of flooding and abatement and the average flooded period from average time of flooding to average time of abatement (adapted from Focus Groups, questionnaire data and SADC 1999b).

3.4.3 Socio-economic environment

There is relatively little up-to-date information on the natural resources and socio-economics of this study area, summarised in Chimphamba & Msiska (1997)'s annotated bibliography of the Lower Shire. Most studies are out of date in terms of population estimates, resource use patterns, and particularly agriculture. This is exacerbated by the fact that the policy and political environment has changed considerably in the past two decades, and there has been a massive influx and later repatriation of Moçambican refugees in the study area. In addition, there has been some difficulty in obtaining unpublished information for this site, e.g. poor participation by community members at arranged meetings. Thus, much of our understanding of the area comes from focus group meetings with villagers, discussion with the field project officer and from the use value survey.

3.4.3.1 Social organisation & political structure, institutions

Malawi is divided administratively into three Regions: Northern, Central and Southern. Malawi’s main commercial and industrial city, Blantyre, has a population of 533 000 (Carl Bro Group 1995) and serves as the administrative capital of the Southern Region (Anon. 1998). The three Regions are further divided into a total of 24 administrative Districts, each with a district government office and a District Commissioner. Malawi is also divided along customary lines into Traditional Authorities and Sub-Traditional Authorities, each administered by a traditional chief, e.g. Chief Kasisi, the Traditional Authority of Kasisi and many other villages in Chikwawa district. The chief delegates authority to village headmen. The tribal system is integrated into the government system below the district level, with the Traditional Authority answering to the District Commissioner.

The Lower Shire valley is covered by the administrative districts of Chikwawa in the north and Nsanje in the south up to the Moçambican border. These two districts are transected by 13 Traditional Authorities and two Sub-Traditional Authorities, as well as two Game Reserves, Majete and Mwabvi, and Lengwe National Park, which is administered by National Parks and Wildlife (NSO 1987).

There are three categories of land tenure in Malawi: Customary, Private and Public (Chaweza 1998). Customary land is held in trust for all the people of Malawi by the president, who delegates his authority to the chiefs of the Traditional Authorities. The land is commonly held and distributed to the people by local chiefs and customary land forms about 70% of total land area in Malawi. Smallholder cultivation is mainly done on customary land (Chaweza 1998). Private land is either freehold or leasehold, and often under commercial cropping (Chaweza 1998). Public land is land under infrastructure, forestry, and Game and National Parks (Chaweza 1998).

3.4.3.2 Population size and distribution

The current population of Malawi is estimated at about 11 million people and is growing annually by 3.7% (estimate based on 1987 census; NSO 1987). At the time of the 1987 census, some 350 000 Moçambican refugees were living in Malawi, many of them in the Lower Shire valley. The number of refugees increased to more than a million before the cessation of hostilities in Moçambique, although most have now been repatriated (Ngongola & Kapwepwe 1994, Anon 1998).

The population potentially utilising the Malawian portion of the Lower Shire wetlands was estimated from population figures obtained for the Traditional Authorities of the Chikwawa and Nsanje Districts (NSO 1987). These were adjusted to 1999 figures assuming a constant population growth of 3.7% (CSR 1994). Using ordinance survey maps containing information on large village location (Dept of Surveys 1992), combined with personal observations (F.P.O., pers. comm. and pers. obs.), the proportion of each the Traditional Authority population that resided within the defined study area was conservatively estimated. The population within this portion of the study area was estimated to be 349 525. This population estimate implies a density of 190 people per km^2 on the Malawian part of the floodplain, which is significantly higher than the estimated national average of 133 people per km^2 (adapted from Ngongola & Kapwepwe 1994). The population of the Moçambican portion of the study area was estimated using population density estimates for the administrative posts of Charre, Megaza and Chire (Schmidt 1997; adjusted to 1999 figures at 3% growth), which ranged from 102 to 19 people per kilometre squared respectively. The population in this portion of the study area was estimated to be 45 070, which gives a total estimated population for the entire study area of 394 595 and an overall density of 162 people per km^2. This estimate conservatively excludes the urban populations of Chikwawa and Nsanje (approximately 32 000 people) as no data is available on the extent to which urban populations in the Lower Shire utilise the wetlands. Much smaller semi-urban centres such as Ngabu and Bangula are included in the population estimates.

A baseline survey of the Nsanje district estimated average household size at 5.12 persons per household, which was higher than the 1987 census estimation of 4.37 persons per household for the district (CSR 1994). This study found an average of 6.8 persons per household, implying 58 029 rural households in the study area. Most households live along the western margins of Elephant and Ndinde Marshes and along the major road that runs north-south from Blantyre to the Moçambican border (Timberlake 1997, CSR 1994, pers. obs.). The major urban centres are also situated along this road (Fig. 3.6). The majority of the larger villages are immediately adjacent to, or within 7 kilometres of the wetlands proper (Dept of Surveys 1992). There is also a concentration of population along the eastern margin of Elephant Marsh on the higher ground at the foot of the escarpment. The majority of the population in the Moçambican portion of the study area live around the southern end of Ndinde Marsh (Schmidt 1997). Many floodplain and upland households have agricultural plots out on the marshes, and some household members either tend them on a semi-permanent basis, spending several days a week residing in temporary structures, or daily (smallholder interviews, pers. obs.). Cattle are also driven out of the uplands and floodplain grasslands daily to drink from the wetlands and main channel.

3.4.3.3 Economic activities

Malawi has some of the most fertile soils for agricultural use in southern Africa (Chaweza 1998). Since the rapid expansion in agriculture from the mid 1970s to the late 1980s, about 85% of Malawi's work force is in the subsistence sector, engaged in smallholder farming of maize, rice, cassava, groundnuts, cotton, livestock and some subsistence fishing (Anon. 1998, Chaweza 1998). Agriculture is thus the backbone of the Malawian economy. Several commercial irrigation schemes and the large ILLOVO sugar estate also lie in the Lower Shire valley, providing large-scale employment and export produce.

Approximately 50% of the population on the Shire floodplain in Malawi is between the ages of 15 and 65 and potentially economically active (CSR 1994). Most people in the Nsanje district are self-employed in subsistence agriculture (CSR 1994) growing primarily maize, sorghum, rice, cassava and several fruits. There is a large amount of subsistence fishing as well as some commercial fishing. Few people are employed in cash labour, mainly in sugar cane growing and processing, in National Parks and Wildlife Reserves and in the urban centres, and about 25% of households earn cash from informal non-farming enterprises (CSR 1994).

3.4.4 Pressures on natural resources

The wetlands of the Lower Shire, particularly Elephant Marsh, are probably the most impacted wetlands in the entire Zambezi Basin (Timberlake 1997). Major changes in species composition and ecology have been reported over the last 100 years, particularly since settlement intensified along the western boundaries (1950s; Timberlake 1997). The major factors causing wetlands degradation and a threat to the remaining biodiversity are:

- Massive population pressure, resulting in human encroachment onto the floodplains, especially during dry periods;
- Agricultural and urban developments, both on the floodplains and in the catchment of the Shire River;
- Hydroelectric dams and controls on river flow - the Lower Shire has a barrage and a dam is being constructed - which prevent peak floods and increase flow during the dry season;
- Hunting, though particularly in the early part of this century when most of the damage was done, and thus currently on a relatively small scale;
- Over-fishing; and
- Deforestation on the surrounding Lower Shire watershed.

In particular, agricultural runoff and Blantyre sewage have lead to eutrophication of the wetlands and a proliferation of water weeds (e.g. *Salvinia molesta, Eichornia crassipes, Pistia stratiotes*) which have resulted in a decline in fish production and biodiversity (Timberlake 1997)

3.5 THE ZAMBEZI DELTA

3.5.1 Study area

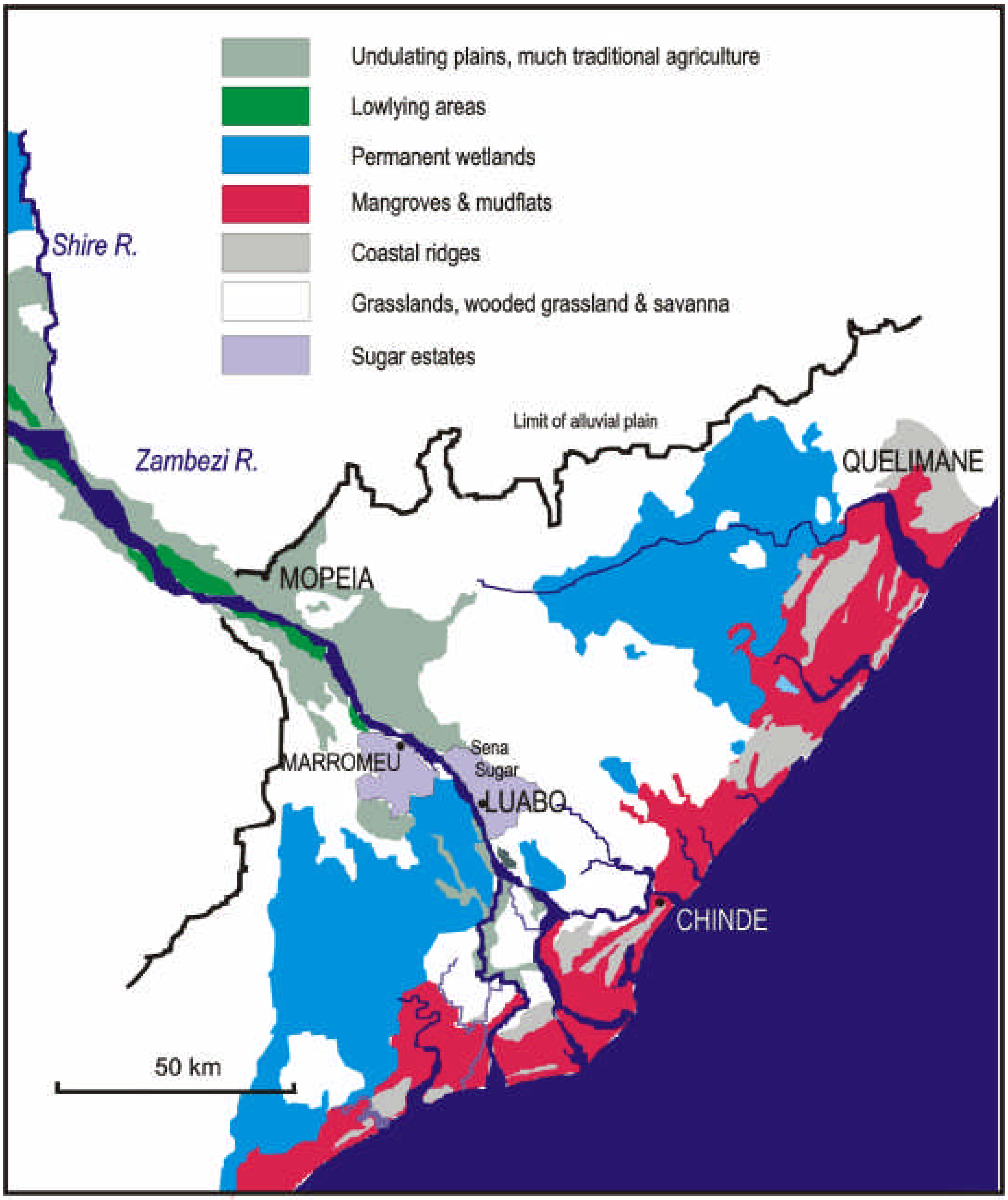
The Zambezi Delta extends in a large triangle from Mopeia in Moçambique to the coast (Fig. 3.8). Mopeia is about 120 km upstream from the mouth of the Zambezi. The northern boundary of the Delta is along the Rio Cuacua to the town of Quelimane at the coast (Sweco 1982, Timberlake 1997). The southern section is smaller and extends as far as the Mungari River (Sweco 1982). Alluvial plains, which are flat and mostly below 30m above sea level, cover the whole Delta region and are surrounded by Moist Forest Woodland Mozaic (Datton & Munguambe 1997). The alluvial plains, which comprise extensive areas of wetland, grassland and riparian or floodplain vegetation, have an intricate reticular drainage system. Tidal influence and saline water extend up river for some distance from the coast, and in low flow periods, increased salinity can be evident up to 80 km from the sea.

The Delta can be divided into six physiographic regions (Sweco 1982, based on the Loxton reports, *ca* 1971-5):

1. *Tidally influenced areas occupied by mangrove swamps*.
2. *Seasonally flooded areas with tidally influenced drainage lines*. Occurs inland of the mangrove swamps, mostly occupied by hygrophileous grasslands and aquatic communities.
3. *Seasonally flooded areas*. These are too wet for much other than rice in the south, but are not as wet in the north. In the north this region includes part of the Sena Sugar estate.
4. *Relatively elevated floodplains and back slopes of levees, periodically flooded*. Parts of these areas were cultivated with sugarcane around Luabo and Marromeu. Flooding of these areas has decreased.
5. *Elevated levee and water course areas*. The landscape is hummocky, with grasslands in the depressed sites and riverine woodland and *Acacia polyacantha* woodland in the drier areas, and is well populated with traditional farmers.
6. *Raised beaches.* These are mainly near the coast, and have low fertility and production potential. However there are extensive coconut plantations in these areas north of the Zambezi.

The area of the Delta is approximately 1.4 million ha (estimated from 1:250 000 ordinance survey country maps and Sweco 1982, Fig 3.8). The study area for this preliminary study was delineated on the basis of political boundaries defined by Schmidt (1997) in her socio-economic study of the area. Schmidt (1997) takes the seven districts bordering the Zambezi from the Shire River to the mouth as the limits of the study area. These districts essentially make up most of the Lower Zambezi Valley. This study considers the Delta proper, from Mopeia to the coast, and thus incorporates only three of the districts included in the above study: Mopeia and Chinde in Zambézia Province to the north of the river and Marromeu in Sofala Province to the south. These three districts together make up 1 789 000 ha. Strictly, a more detailed study should also include the districts immediately to the north (including Quelimane) and south (Cheringoma) of these to include all of the Delta wetland. Nevertheless, our study area is broader than the study area defined by ZBWCRUP in which work is being carried out by the Field Project Officer.

Figure 3.8. Map of the Zambezi Delta



The only protected areas and controlled hunting areas in the Delta are south of the Zambezi (Table 4.5.1). The protected areas in the Delta are the Marromeu Buffalo Reserve (150 000 ha) which is dominated by floodplain grassland, and the Nhapakwe Forest Reserve (17 000 ha), which is outside of the wetland proper. There are three hunting concessions (*Coutadas*) in the study area, all of which include part of the Delta wetlands: Coutada 10 (200 000 ha), Coutada 11 (193 000 ha) and Coutada 14 (135 000 ha) (Hatton & Munguambe 1997). In the north there is a private game farm which offers sport hunting (E. Hiscock, pers. comm.). Relatively few concessions for agriculture are being used, and none are being used for mining, forestry, livestock or non-consumptive tourism in the Delta at present. The state is considering a number of applications in the Delta (Table 3.2).

Table 3.2. Protected areas and concessions in the three districts of the Delta study area (based on Schmidt 1997)

	Mopeia	Chinde	Marromeu
Total area (ha)	766 800	435 100	587 100
Area of reserves			150 000
Area of forest reserves			11 333
Total area of controlled hunting areas			399 100 (68%)
Agricultural Concessions	100	17 000 (Madal coconut and rice)	10 200 (Sena Sugar - 50 ha in use)

We consider the original habitat breakdown of the 1 275 000 ha of wetland to be roughly as follows:

- Palm savanna: 5% (63 750 ha)
- Floodplain grass: 40% (510 000 ha)
- Wet grass: 25% (318 750 ha)
- Reeds & papyrus: 10% (127 500 ha)
- Channel: 5% (63 750 ha)
- Mangroves: 15% (191 250 ha)

The Delta falls partly within the sub-humid and mostly within the sub-humid to humid bioclimatic regions, with an annual average temperature of 26°C, rainfall of 1000-1200 mm, and an average humidity of over 70% (Sweco 1982). The hot and rainy summer season lasts from November to March or April, and the moderately warm and dry winter season is from May to August.

The Delta area originally experienced high water in January to April and low water in October to November. Low-lying floodplains were saturated with floodwaters for up to 9 months of the year (Beilfuss & Davies 1999). Now 70% of the catchment is regulated by dams, which have caused large alterations in the normal flow variations (Sweco 1982). After the construction of Lake Kariba, the reduction in downstream flooding desiccated the Delta's alluvial soils, causing salinization and invasion of upland woody vegetation into the floodplain grasslands. With the closing of the Cahora Bassa dam, the flood cycles were lost altogether and the hydrological connection between the river and its floodplain was severed. Inundation is now dependent on local rainfall runoff within the lower Zambezi subcatchment, or unplanned water releases from upstream dams (Beilfuss & Davies 1999).

3.5.2 Socio-economic environment

3.5.2.1 Population size and distribution

Schmidt (1997) estimated the 1997 population of the Zambezi delta, based on 1984 census data, and incorporating the districts of Marromeu in Sofala Province, and Mopeia and Chinde in Zambezia Province (Table 3.3). The census results from 1997 were released in 1999. Although Schmidt (1997) noted that populations in all districts had declined due to death and emigration to the big cities during the civil war (Schmidt 1997), this effect seems to have been even larger than she accounted for (Table 3.3), with census data revealing a total population of just over 270 000, in 66 752 households. This study found an average of 4.1 people per household, which compares very well with the census average of 4.05 people per household.

Table 3.3 Population numbers in districts of the Zambezi Delta (Schmidt 1997, Census data 1997).

District	Area (ha)	Estimated 1997 population (Schmidt 1997)	1997 Census		Estimate of 1999 rural population	
			Pop-ulation	House-holds	Pop-ulation	House-holds
Marromeu	587 100	79 238	69 895	16 287		
Mopeia	766 800	86 234	71 535	17 109		
Chinde	433 100	175 992	129 115	33 567		
Total for ZBWCRUP project area			199 010	33 396	182 709	45 113
Total for study area		341 464	270 545	66 752	248385	61 330

The most densely populated area in the Delta is around Chinde. The Delta itself has a relatively low population density compared with other areas further north in the Lower Zambezi Valley. The total population used in this study does not include that of the Quelimane area to the north east of Mopeia district. However, since the Mopeia district boundary extends slightly beyond the Delta area to the north west, it is assumed that these factors balance one another out.

The active ZBWCRUP project area is somewhat smaller than the extent of the Delta, forming a narrower wedge around the river. This population includes most of the Marromeu and Chinde district population, but excludes most of the Mopeia population, and Quelimane. Thus within the project area, the population is estimated to be 199 000, comprising 33 396 households.

Using a mean growth rate of 1% and an estimated urban component of 10%, present-day (1999) rural population numbers were estimated as approximately 61 000 households in the Delta study area and 45 000 households in the Project area (Table 3.3). This study extrapolates findings to the whole Delta area, but also presents summary findings as extrapolated to the ZBWCRUP project area.

Based on data for Safrique (Barbosa *et al*. 1997c), the population comprises roughly 20% men, 20% women and 60% children.

3.5.2.2 Political and economic history

The history of the Lower Zambezi Valley is summarized in Schmidt (1997). Indigenous agriculture thrived in the valley undisturbed until the slave trade collapsed in the 1850s and Portuguese settlers developed an interest in commercial agriculture in the region. Indigenous household economies were then increasingly affected by forced labour recruitment to plantations and then compulsory production of certain cash crops during the first half of this century. Labour became increasingly voluntarily sought, as the agro-industries and plantations started to dominate the economy of the Delta and the amount of land available per smallholder family was reduced from 15 ha in the 1930s to 1 ha in the 1970s. After independence in 1975, there was a massive exodus of the Portuguese, and commercial agriculture collapsed. Locals also left the region during the long civil war that followed. The Peace Accord was signed in 1992, people have started moving back into the region, and there are signs that there will be an economic upswing in the area (Schmidt 1997).

There is currently a traditional system of leadership as well as a governmental system. Villages are run by administrative committees which are politically aligned to either of the two parties in central government: Renamo or Frelimo. The tribal system has been effectively disempowered in the past, but still has influence in some areas. The institutional setting for resource management is thus complex and differs from area to area (B. Chande, F.P.O., pers. comm.).

3.5.2.3 Economic activities

A literature review of socio-economic characteristics of the Delta region has been produced by Schmidt (1997), and village-level studies have since been carried out at seven villages within the three districts that comprise the study area (Barbosa *et al*. 1997a-g). The villages are listed in Table 3.4.

Table 3.4. Villages studied by Barbosa *et al.* (1997a-g).

Province	Zambézia			Sofala			
District	Mopeia	Luabo	Chinde	Marromeu			
Village	Dande	Caoxe	Tanque	Safrique	Cheuza	Nvunganha	Malingapanse
Population	192 families	no data	no data	3512 in 720 families	no data	no data	no data

Inhabitants of the Delta have a largely subsistence economy (Barbosa *et al*. 1997 a-g), and more than 95% of households are dependent on agriculture (Schmidt 1997, based on dTp Studies 1996, Lof & Hendersohn 1996). Nevertheless, in Marromeu town, approximately 85% of households generate some cash income. About 60% of households generate income from the sale of agricultural products and 45% earn income from labour. However, most households operate in 'survival mode', concentrating expenditure on food and clothing (Schmidt 1997) and non-agricultural income sources are never fruitful enough to replace the existence of agricultural sources (Negrão 1995, in Schmidt 1997). Most villagers are considered poor (Barbosa *et al*. 1997a-f).

Smallholders use slash-and-burn practices, which deforest areas and contribute to reduced soil fertility. This is now being discouraged by NGOs in the region (Schmidt 1997). The most important crops are maize, rice, sorghum, millet, sweet potato and manioc. About half of households grow vegetable crops and 25-50% have fruit trees and/or coconut palms (Schmidt 1997). These percentages are higher in the Marromeu - Chinde region, where virtually every household has fruit trees (E. Hiscock, pers.

comm.). Livestock are not very important, and are dominated by chickens, as well as ducks, pigs and goats. Agricultural production is mainly limited by lack of equipment such as tractors. A considerable number of families produce an excess which they sell. Products are marketed in Luabo, Mopeia and Marromeu. Other activities include fishing, hunting, and producing artefacts for sale. The production and sale of palm wine (*Sura*), mainly from *Hyphaenae* sp., is also important for a number of families.

Both sexes are responsible for agricultural production and supplementing family income. The same is true of collection of products such as firewood, grass, construction materials, medicinal plants and edible plants. Men are responsible for hunting, fishing, construction and business. Women concern themselves with cooking, pounding cereals, making clay items, and are largely responsible for the collection of forest products, firewood and water. Men cut the firewood and also cut poles in the woodlands and extract palm wine (*Sura*). Transportation is variously undertaken, depending on mode. For example, if the man of the household owns a bicycle, he will transport wood and water, but if not, this responsibility falls to the women.

Economically, the communities of the Delta can be divided into coastal and inland communities. The former can be distinguished by having marine and estuarine fisheries and coconut production.

4 DIRECT USE VALUES

4.1 INTRODUCTION

This study examines the present use values of the four wetland study areas during 1999. We concentrate on consumptive use values of resources used by the rural communities associated with the wetlands, and consider the value of commercial ventures, including for non-consumptive use (e.g. ecotourism, irrigation schemes), to a lesser extent. Commercial users from outside the study areas were not surveyed. In addition, this study does not take into account any multiplier effects or linkages that may be felt beyond the wetlands due to commercial activities. Most data pertain to 1999, but it must be noted that this may not necessarily be a typical year. Most of the study areas were experiencing relatively good years at the time of the study, having gone through droughts earlier in the decade.

Prior to this study there has been very little research on the use of wetland resources in this region, let alone the economic value of this use. There was also an almost complete absence of existing data on the quantities and status of resource stocks that people use. Thus it was necessary to collect basic data on the types and quantities of resources used, and to rely to a large extent on local knowledge of the state of the stocks of these resources.

4.2 STUDY APPROACH AND VALUATION METHODS

The study was carried out in two phases. During the first phase, reconnaissance visits were made to each study area in order to get a feel for the study areas, to collect existing data, and to have meetings with Field Project Officers and with other government & private sector representatives, in the four study areas and in other major centres. Meetings were also held with local community representatives in each of the study areas and villages. The aim of the village meetings was to find out what resources were used, and to make an initial assessment of their relative importance and value. Village meetings were held in three of the four study areas. Village meetings could not be held in the Delta due to logistical difficulties. However, a recent study of resource use by seven villages in the study area made up for this. The way village meetings were conducted differed from site to site, and were used to test some aspects of methodology to be applied during the second phase of the study.

In Barotseland, meetings were held in Ndau (15º20'S, 22º57'E) and the royal village of Lealui (15º14'S, 23º01'E), on the floodplain. About 140 adults attended the Ndau meeting, including representatives from throughout the Lumbo subdistrict incorporating the Ndau , Lulambo and Lama village groupings. The meeting in Lealui was attended by 91 of the approximately 300 adults in the village area.

In the Caprivi, meetings were held at three small villages, with about 8 to 12 adults at each meeting. Three village meetings were held in the Lower Shire, at Mpokongola village, attended by 19 men, including two chiefs (women appeared to be excluded), at Chief Kasisi's village (16 01 S, 34 47 E), attended by 12 men and nine women from two villages (Mbenderana and Linawa), and at the Nkhate Irrigation Scheme (16 09 S, 34 47 E), attended by six men and three women from the scheme management committee, 15 men from the agricultural committee, two men from the disciplinary committee, one man from the irrigation committee and three other farmers, totalling 31 people.

In the Lower Shire, perceptions of the importance of fish and other wetland resources relative to livestock, crops, upland resources and income from wage labour were obtained at village meetings, and this method was repeated in the household surveys at all sites. The villagers were asked to represent the annual value accruing from each of these resources by means of distributing a pile of beans among the five options presented. The beans were placed by one volunteer, but all members of the meetings participated in deciding how to place them. This was usually accompanied by lively debate.

The information gleaned in village meetings during the first phase of the study, coupled with existing data, were used as the basis for a preliminary assessment of economic values, and for the design of survey instruments for application in the second phase of the study, to assess use value of the wetlands. Both household survey and focus group discussion instruments were used in each wetland.

4.2.1 Household surveys

The main aim of the household survey was to obtain quantitative data on the use of wetland resources. The household surveys differed slightly from wetland to wetland. In general, refinements were made to the instrument with each iteration, from Barotse, to the Lower Shire, Delta and Caprivi wetlands. The general structure of the surveys is described in Box 4.1. The full survey is in Appendix 2.

Surveys were carried out by two teams of two local enumerators in each wetland after a training period of one week. All surveys were presented to the enumerators in English or Portuguese, but were administered in the local language. Individual households were approached systematically within a stratified frame. Stratification was aimed at getting adequate coverage of the main diversity of communities of the study areas. The survey questionnaire was read out to the head of the household by one enumerator while the other recorded responses on a data sheet. The surveys each took approximately 40 minutes to 1h45 to complete. A total of 138 surveys were completed in the Barotse floodplain during March 1999, 60 in the Caprivi during July 1999, 100 in the Lower Shire during April 1999, and 90 in the Delta during June 1999.

Data were entered into spreadsheets and vetted and cleaned for analysis. Quantities were expressed by respondents in numerous ways. Thus, during data cleaning, all quantitative data had to be converted to common units (e.g. same sized bundles, kg of fish).

Data from the surveys were analysed to try and detect cross sectional patterns and trends of interest. The results of this analysis were used to help describe the economic characteristics of the wetlands and as inputs into scenario analysis.

Box 4.1 General structure of the household surveys.

HOUSEHOLD SURVEYS

A. Household information.
Household size and composition

B. Relative value of household production
Respondents were asked to apportion a pile of beans among six different sources of income (crops, livestock, upland natural resources, fish, other wetland natural resources, and cash income from jobs), to indicate the relative benefits (cash and non-cash income) obtained from these resources in an average year.

C. Wetland and floodplain resources
Respondents were asked about fish, crustaceans, other animals, mangroves, palms, reeds, grasses, and foodplants, as applicable to each study site. For each resource they were asked about the following:
- whether they harvest the resource, and which species are harvested
- which members of the household harvest, by age and gender
- what equipment is used to harvest
- amount harvested over the past year,
- effort and harvest rates in peak and non-peak periods,
- distance and time to travel to and harvest the resource,
- whether the resource is bought or sold, and if so, how much
- losses to wild animals
- whether the household obtained enough for their own use

D. Livestock
Questions were asked on the following:
- numbers of small and large stock
- composition of cattle herd, number of milking cows and milk production
- months cattle are kept in the uplands and wetlands
- whether the household seasonally tends cattle from upland households
- labour by household members, and paid labour
- Sales, purchases and slaughter of cattle in the last year

E. Crops
Questions were asked on the following:
- total area cultivated, which crops grown, and area cultivated for each
- amount produced in the last year for each crop
- amount sold or exchanged, and price obtained
- household labour on crop production
- fertiliser, manure and seed inputs
- crop losses to wild animals
- household reaction to poor crop years

F. Processing and crafts
Households were asked to list the productive activities which they were engaged in which used wetland or crop products as an input. For each type of product, questions were asked on the following:
- who makes it, and how much produced in a year
- what materials, tools, equipment and labour inputs are required
- whether it is made for sale, and income generated

G. Cash income
Respondents were asked about details of employment in the household, cash income from pensions and work.

H. Interview assessment
Finally, the interviewer recorded the length and quality of the interview, and provided his assessment of whether the household was within the top, middle or bottom third of households in the study area in terms of wealth.

4.2.2 Focus group discussions

The purpose of the focus group discussions was to obtain information on the use of resources which was of a general nature, and for which quantification at the household level would not be necessary. Focus group discussions involved gathering a group of five to ten people who were well versed in the topic for discussion. Focus group discussions were held in each of two to three parts of each study area, on each of the following topics (where applicable): crops, livestock, mangroves and palms, reeds, papyrus and grass, wild foods, and fish. Focus groups were carried out by the consultants, using trained enumerators as translators and scribes. Meetings were arranged in advance, and each focus group session lasted approximately 1 - 1.5 hours. The elements contained in the focus group discussions are described in Box 4.2. Full focus group instruments are in Appendix 3.

Box 4.2. General structure of Focus Group discussions.

FOCUS GROUP DISCUSSIONS

A. Introductions

B. Resource description
All crops or species of natural resources were named and described in detail, giving where they occur or are grown. Their treatment and uses were also described.

C. Rules of access
The group was asked to describe how households gain access to resources, whether there are limitations on use, who monitors use, and what happens if rules are violated.

D. Who is involved
People were asked about the role of men, women and children in the production or harvest of the resource.

E. Equipment
The group was asked about the type of equipment used, its price, durability, and whether it is shared amoung households.

F. Seasonality
The group was usually first asked to describe seasonality in flooding levels, as a practice exercise to creating a trend calender using beans. They were then asked about seasonality in the availability and harvesting of the resource, In the case of crops they were asked about seasonality of different activities (e.g. cultivating, harvesting) for each type of crop.

G. Returns to effort
The group was asked how much could be harvested in a day during different times of year.

H. Prices
Selling prices were obtained for each resource and for products made from these resources.

I. Changes in availability
Members of the group were asked to describe the changes in availability over the last five years and over the last four decades, using beans. The group was then asked to explain the patterns shown.

J. Attitude to biodiversity
The group was asked whether diversity in the resource was important. For example would it be equally good if there was only one species, as long as overall abundance stayed the same?

4.2.3 Static analysis: calculation of annual use values

The value of each resource was estimated using a static economic model. The model was developed based on an existing approach developed by the Namibian Directorate of Environment Affairs (e.g. Ashley *et al*. 1994, Barnes & de Jager 1995, 1996, Ashley & Barnes 1996, Barnes 1996) for estimating the financial (private) and economic (societal) costs and returns to livestock, cropping, natural resource harvesting and tourism activities. The model combines the market value approach and the net factor income approach. The generalised structure of the model is described in Box 4.3.

Box 4.3 General structure of the model used for estimating annual use values

STATIC FINANCIAL AND ECONOMIC MODEL SECTORS

1. Capital Requirements

The value of fixed, movable and working capital are estimated for the enterprise. Fixed capital comprises domestic items such as grain storage sheds, boreholes, fish drying racks, and tradeable items, such as fencing. Movable capital includes domestic items such as fishing nets, canoes and tradable items, such as tools, boats, shares in vehicles and ploughs. Working capital is estimated as 30% of annual variable expenditure.

2. Gross income

Annual outputs are multiplied by the market value per unit output to calculate the gross financial income.

3. Variable costs

These include tradable items such as seed, fertiliser, salt, ploughing and casual labour, and domestic items such as vet costs, fishing or hunting licences and park entry fees.

4. Fixed costs

These are domestic costs and include skilled and unskilled labour, insurance and maintenance and repairs. Maintenance costs are estimated as 6% of movable capital plus 1% of fixed capital value.

5. Calculation of financial and economic returns

In the *financial model*, an annual financial (private) net income, the *net cash income,* is calculated as gross income less fixed and variable costs. It includes both cash returns and consumption. Fixed costs include the fixed costs described above plus loan amortisation costs (at 10% interest rate), provision for capital replacement, and interest on the 30% borrowed for variable and fixed annual costs (working capital). It also includes land rentals and resource royalties. For subsistence activities, it was assumed that no loans are taken for capital costs. The interest rate for working capital loans is assumed to be 15%. Financial net cash income for small-scale household activities is measured as return to both financial inputs and labour.

In the *economic model*, the annual economic net value, measured as the *net value added to national income*, is calculated. The economic measure is mostly derived from financial data, to which shadow pricing criteria have been applied to determine social costs and benefits at the national level. It is gross income less economic costs all at economic prices, and provides a measure of economic efficiency. Interest, taxes and subsidies are ignored as transfers, labour prices are adjusted to take account of unemployment, a foreign exchange premium is applied to tradable items to reflect excess demand for foreign exchange, foreign inflows and outflows are treated as benefits and costs respectively, and the costs of land and government sectoral expenditures and working capital costs are excluded.

Basic data and adjustments used in the models are listed in Table 4.1. Tax adjustments were not made for subsistence activities.

Table 4.1. Shadow pricing factors, exhange rates and labour wage rates used for the different countries.

	Zambia	Namibia	Malawi	Moçambique
Currency	Z Kwacha	N $	M Kwacha	Meticais
Exchange rate (local:US$)	2125	6	44.75	12 500
Cost of labour (per day)	2125	21	45	5000
Shadow wage rate adjustment	0.15	0.35	0.15	0.15
Forex adjustment factor	1.20	1.06	1.20	1.20

The capital and variable inputs, their price and durability, were determined for each resource on the basis of focus group and household survey data. Where one input, e.g. a canoe, was used for more than one activity (e.g. fishing and collection of reeds), then the value was divided among the different activities accordingly. The annual cost of capital assets was estimated using straight-line depreciation, based on the average durability of the item. Labour inputs for natural resource harvesting were calculated using time for a harvesting trip, amount collected per trip, and total amount collected per year. Labour costs for agricultural activities were obtained from household surveys and focus group data.

Average outputs per household were obtained from the household surveys, and values were obtained from a combination of household and focus group data. Current world prices were used for the economic value of crop production. Data for each resources are presented in the following form (Table 4.2), either per user household, or for the entire wetland area (using total number of households and the ratio of user: non-user households).

Table 4.2 Explanation of the terminology used in value tables in Chapter 4.

Measure of value	**Explanation**
Gross value (financial)	- the total market value of the harvest, based on local prices
Gross value (economic)	- as above, but using forex-adjusted shadow prices for tradeable produce
Net value (financial)	- gross financial value minus input costs, based on local prices
Net value(economic)	- gross economic value minus economic input costs, and minus labour costs, based on the shadow wage rate
Gross cash income (financial)	- cash earnings to the household from sales
Gross home value (financial)	- local market value of consumed production
Net cash income nd net home value are not presented but can be calculated using the ratio of gross financial value: net financial value	
Gross returns to labour (financial)	- gross financial value generated per day of labour
Gross returns to land (financial)	- gross financial value generated per ha of productive land
Gross returns to land (economic)	- gross economic value generated per ha of productive land
Net returns to land are not presented, but can be calculated using the ratio of gross value:net value	
Cash returns to land (financial)	- cash income generated per ha of productive land

4.2.4 Dynamic analysis: calculating net present value

This analysis yields the net present value of the wetland is the discounted sum of the net benefits accruing from the present year into the future, and is dependent on a number of factors. The methods and results of the dynamic analysis are presented in Chapter 7. Only current use values are presented in Chapter 4.

4.3 THE BAROTSE FLOODPLAIN

4.3.1 Livestock

Cattle, mostly the Barotse breed - a long-horned Sanga type, are the most important type of livestock, and pigs, goats, donkeys and chickens are also kept. Small stock are considered relatively unimportant. Cattle are a form of wealth and a source of milk, manure, meat, bridal dowry and monetary income. They are only rarely slaughtered traditionally for meat (Simwinji 1997). Nevertheless, live cattle marketing in the province is intensive and cattle buyers do slaughter as well as transport beef on the hoof to Lusaka. All cattle are managed traditionally, except for one dairy farm in Mongu. Rangelands are essentially common property, and are being degraded by uncontrolled and late fires (Simwinji 1997). Burning starts as soon as the grasses become dry enough after the flood waters recede. Late burning is an attempt to provide regrowth when the grasses have all been heavily grazed.

Most of the province's cattle are found along the Zambezi flood plain and adjoining plains (Jeanes & Baars 1991), and the Barotse floodplain is one of the most productive cattle areas in the country (Simwinji 1997). The wetlands are thus of significant economic importance to the economy of the province. Western Province is divided into four grazing management systems totalling 12.1 million ha, of which one is the Bulozi Plains System, covering 1.9 million ha (Jeanes & Baars 1991). The geographical limits of this area are only roughly sketched in Jeanes & Baars (1991), but essentially include the Lungwebungu wetlands, Luena Flats, and Barotse Floodplain plus an area of between roughly 10 and 50 km around these wetlands.

A significant proportion of cattle in the study area are managed under a system of transhumance, and move between the floodplains and the adjacent uplands. Most cattle are moved no more than 15 km from the wetland, but some are moved as far as 50km (E. Chileshe, pers. comm.). Some cattle owners have houses on the floodplain and uplands, and in other cases there is co-operation between relatives and friends (a *Mafiosi* system). The annual transhumance is important for the distribution of manure, and in the floodplain there is a strong interaction between herding, cropping and fishing activities (Simwinji 1997). Natural pastures form the main feed for cattle, and crop residues account for 5% of their intake (Simwinji 1997). Cattle manure is thought to increase fish productivity in the wetlands as well as fertilising agricultural fields (van Gils 1988). The crop-livestock interaction is important, but the two systems do compete for space.

The length of time that cattle spend in the flood plain is determined by the degree and duration of inundation (Jeanes & Baars 1991). Cattle generally spend July to January in the flood plain and the remainder of the year in the uplands (Simwinji 1997). According to villagers, the period spent in the uplands is about 4 months. Cattle movements into and out of the wetland were described by focus groups and household respondents as follows (Fig. 4.3.1).

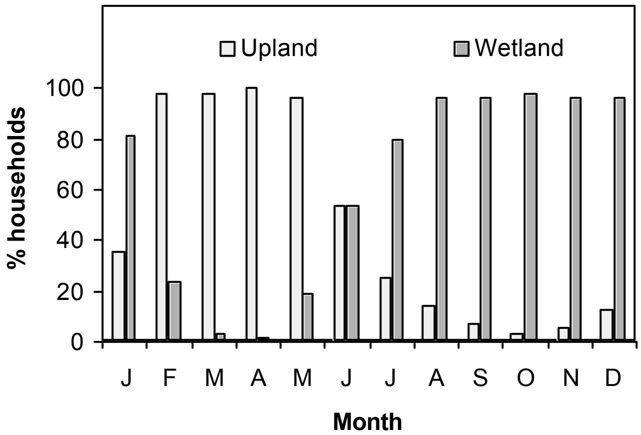


Figure 4.3.1. Seasonal movement of cattle between the Barotse Floodplain and the uplands (household survey data).

The province's carrying capacity is estimated to be 1 033 000 LSU (large stock units; Jeans & Baars 1991, Simwinji 1997). Cattle and large stock units are roughly equivalent (1 LSU for Western Province = 260kg - E.C. Chileshe, government range ecologist, *in litt*.; average mass of cattle is 259kg - Mwafilurwa & Moll 1991; thus 1 head of livestock = 1 LSU). Development of water points in dry areas would increase the potential carrying capacity by about 200 000 LSU (Jeanes & Baars 1991). The lowlands (floodplains, dambos, pans and valleys) account for 74% of the potential carrying capacity of the province. The province is divided into four cattle management areas, one of which - the Bulozi Plains System - defines the study area. The carrying capacity of cattle in the 'Bulozi Plains System' is 306 000 LSU, and with increased watering points in the upland areas, could be increased to 317 000. The potential stocking rate in this area (6ha/LSU) is more than double that in all other management areas except for the other wetland-dominated system (the north-west wet plain system - 11 ha/LSU).

Actual numbers of cattle in the province are considerably lower than carrying capacity. There are about 560 000 cattle (and 46 000 cattle owners) in Western Province (Maimbo et al. 1996, Dicko 1992, Bbalo 1996 in Simwinji 1997), of which about 184 000 are managed under the transhumance system (Dicko 1992, Nkhata & Kalumiana 1997).

There are no accurate records of the number of cattle in the study area. According to Simwinji (1997), the Barotse plain and associated plains of the Lueti and Luena rivers account for 37% of the cattle in the province (207 000). Other sources suggest that the numbers may exceed the carrying capacity for this area: Numbers on the floodplain reportedly swell to 400 000 for a period of four to five months (Evalisto Chileshe, Department of Research and Specialist Services, Ministry of Agriculture, Food & Fisheries, pers. comm.). In this study, the household survey found that 47% of households in the study area keep cattle, and cattle owners owned 21 head of cattle on average. In addition, 34% of wetland households keep cattle belonging to upland households during the wetland grazing period. Based on the these survey data, we estimate the total number of cattle belonging to residents of the study area as 265 900 head, and that a total of 435 000 cattle are grazed on the floodplain during the non flood season. Wealthier households own cattle, and wealthier cattle owning households have significantly more cattle than poorer households (Fig. 4.3.2).

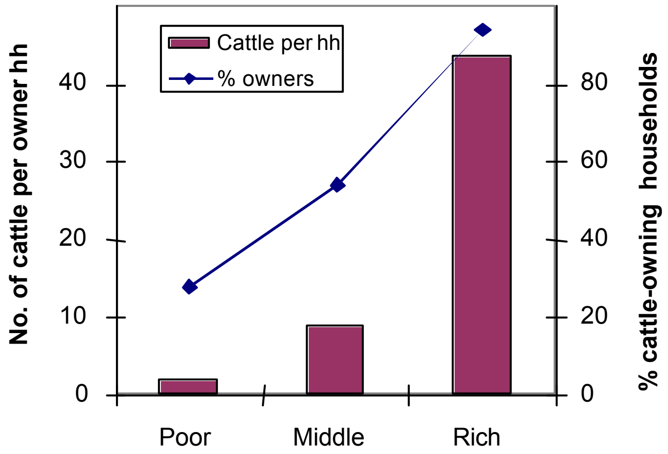


Figure 4.3.2. Percentage cattle-owning households and average herd size among poor, middle and rich status Barotse households (household survey data).

Cattle productivity is generally low. This is partly due to the tendency to concentrate on stock numbers rather than quality. Low fertility and high calf mortality rates are also attributed to low nutrient availability during the flood season, poor management and outbreak of diseases. The cattle lose condition during the dry season, when they spend a lot of time on the floodplain margin due to demands for manure there.

On average, cattle owners sell 5.1% of their cattle per year, and slaughter another 1.4% for own use. A total of 44% of cows were reported to be milking cows, producing an average of 1.04 litres of milk per day. This yields an estimate of 167 litres per cow (all cows) per year, which is slightly higher than the estimate of 120 litres used by Mwafulirwa & Moll (1991) in their economic analysis of cattle for the whole of Western Province. The value of grazing in the study area was taken to be the productivity of cattle during the months they spend within the floodplain area, including the value of milk and manure production. 86% of households use herdboys from their own households, and 33% hire herdboys at an average wage of ZK400 per day. Because labour is mainly undertaken by children, the latter was the wage rate applied to household labour in the model. Results are summarised in Table 4.3.1.

The current net economic value of cattle herding in the Barotse wetland is almost $4 million per annum (Table 4.3.1.), and to rural households, cattle are worth $3.3 million in financial terms. The true value of cattle to households is actually greater than this, because cattle are perceived as a store of wealth. In addition, the contribution that cattle make to cropping in terms of manure production is not taken into account in these calculations. Cropping, in turn, contributes to cattle production in terms of grazing of stovers (crop stubble and residues). These values are assumed to be in balance.

Table 4.3.1 Annual values associated with cattle grazing on the Barotse floodplain, based on household survey data.

	ZKwacha Financial	Economic	US$ Financial	Economic
Per cattle-owning household:				
Gross value	544,485	653,382	256	307
Net value	544,485	640,251	256	301
Gross cash income	505,722		238	
Gross home value	38,763		18.2	
Gross returns to labour (per day)	1,398		0.7	
For whole wetland area:				
Gross value	7,061,476,687	8,473,772,024	3,323,048	3,987,657
Net value	7,061,476,687	8,303,474,752	3,323,048	3,907,518
Gross cash income	6,558,753,347		3,086,472	
Gross home value	502,723,339		236,576	
Gross returns to land (per ha)	132,436	158,923	62	75
Cash returns to land (per ha)	123,007		58	

4.3.2 Crops

The total agricultural land in Western Province is estimated at 279 000 ha (Simwinji 1997). About 90% of the population is involved in agriculture, most of which is for subsistence. Women provide most of the labour for agricultural production. The majority of households hardly produce beyond their subsistence requirements, and yields in the province are generally quite low (Simwinji 1997). Indeed, food self sufficiency for the province is only 62% (Simwinji 1997). The major crops are maize on the plain and on upland fields with the best soils, and sorghum, millet and cassava on the poorer upland fields. Rice is an important cash crop, but its production is thought to be declining due to withdrawal of government subsidies and support from the main buyer, the Western Province Co-operative Union (WPCU; Simwinji 1997). On the other hand, it is argued that, because there is little external input into agricultural production other than labour and draught power, market reforms and the collapse of the WPCU have had little effect on agriculture (Maimbo *et al*. 1996). According to Maimbo *et al*. (1996), there are no options to intensify rice cultivation in the plain, and improvement of soil fertility and of the integration of crop and livestock production is unlikely because of the high labour requirements.

The crop growing period is early to mid November, until late March - early April. Preparatory work is mostly done in October to January and harvesting mostly takes place in March to May. Grain yields are dependent on water availability, especially during the flower initiation period. Rainfall is cyclical over periods of decades. For example, wet years were experienced in the 1940s, latter 60s and early 80s (Van Gils 1988).

A number of different types of fields occur in the study area, as follows (Mulungushi 1986 in Simwinji 1997):

Matema - dryland fields. Upland fields in the woodlands, under shifting cultivation. Fallow periods have become shorter than the original five-year period due to increased populations. The population increase is causing a general decrease in the amount of land available to households in the uplands.

Lizulu - raised garden within the floodplain. These are cultivated with rain fed crops (maize, sorghum, millet), and cover 0.5% of the total flood area; The *Mazulu* in the Barotse floodplain have some of the best soils in the area, but many are fallow because of the risks of flooding, drought and their inaccessibility.

Litongo - village garden. On the upper slopes of the plain margin, and cultivated with mixed rain-fed crops (including vegetables and fruit trees) during the rainy season. Not naturally fertile, but fertilised with cattle manure.

Wet *Litongo* - seepage garden. Used intensively for cultivation of mixed crops. This area is estimated to be 10 000 ha (van Gils 1988).

Sishango - drained seepage garden. Poorly drained, permanently waterlogged areas in which cultivation is risky due to flooding. The soils are difficult to work. The fertility of these acidic peats is raised by burning them which raises the pH and nutrient availability;

Sitapa - lagoon garden. On naturally fertile inner margin of floodplain, planted with maize. Short growing season due to high risk of flooding. Rice-growing potential.

Litunda - small river bank garden. Used for maize and root crops;

In general, the more fertile soils are used for maize production and sandy flood gardens are used for rice crops (Simwinji 1997). Upland people generally have access to *Matema* and *Matongo*, but less to other field types. Land is apparently limited along the fertile plain edges.

All respondents of the household survey were engaged in farming on some scale. The average area cultivated was 2.9 lima, which is 0.74 ha. Field size was significantly positively correlated with household size (n = 136, $P < 0.05$). Richer households tended to be larger, and cultivated larger areas of fields on average (Fig. 4.3.3).

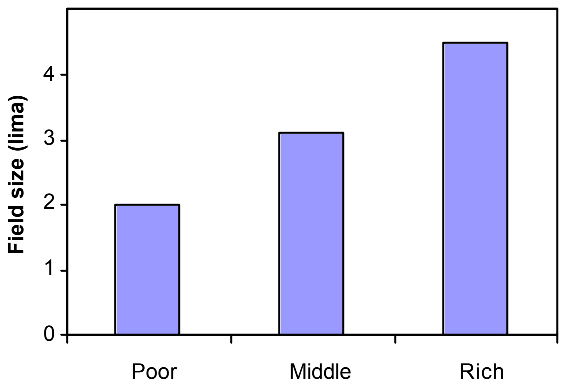


Figure 4.3.3. Average field size (lima) of Barotse households of different wealth status (household survey data).

The survey results suggest that a total of 20 000 ha of the study area is under cultivation. Reported crop area per household was somewhat smaller than the expected 1.7 ha (Guveya *in litt*.). The main crops grown in the study area, mean field size, total area, and their reported yields and prices are listed in Table 4.3.2. Yields were mostly fairly similar to those reported by Mwafulirwa & Moll 1991 for the Western Province, but the maize yield found in this study was considerably lower (617 vs 1150 kg/ha).

Table 4.3.2. The main crops grown in the Barotse study area, mean field size, total area, and their reported yields and prices. Some farmers reported on "vegetables" in general, while others gave areas for each type, hence the inclusion of the general category in the table.

Crop	% farmers	Mean area per hh (ha)	Total area	% area	Yield (kg/ha)	Price 1999 Z Kwacha per kg
Maize	98	0.50	13493	69.0	617	388
Millet	21	0.19	1101	5.6	623	250
Sorghum	2	0.17	97	0.5	580	220
Rice	20	0.23	1267	6.5	1120	306
Cassava	27	0.23	1714	8.8	612	160
Groundnuts	15	0.19	153	0.8	435	289
Sweet potatoes	24	0.11	695	3.6	1230	162
Pumpkins	18	0.09	435	2.2	884	150
Vegetables	15	0.09	380	1.9	1264	178
Tomatoes	5	0.04	48	0.2	600	500
Beans	5	0.11	145	0.7	460	500
Tobacco	1	0.06	17	0.1	?	?
TOTAL			19 545			

In the village meetings, villagers expressed concern that it was not possible to improve maize production in the area, and that they were already limited, presumably in area, by the flooding. It was asserted that farming had declined due to excessive flooding last year. Yet in May 1998 the *Litunga* told the ZBWCRUP manager that floods are no longer as intense as they used to be, highlighting the variability in information within a highly dynamic system. Villagers claimed to be generally short of food, and observation by project staff indicate that this is credible.

The value of agricultural production within the wetland is summarised in Table 4.3.3. Household labour on cropping was just under 1200 hours per year on average. Costs per ha of fertiliser and seed inputs were obtained from Mwafilurwa & Moll 1991.

Table 4.3.3. Annual values associated with the cultivation of the Barotse floodplain, based on household survey data.

	Z Kwacha		US $	
	Financial	Economic	Financial	Economic
Average per household in wetland:				
Gross value	181,516	99,897	85.42	47.01
Net value	180,311	-12,308	84.85	-5.79
Gross cash income	3,468		1.63	
Gross home value	178,047		83.79	
For whole wetland area:				
Gross value	5,008,712,274	2,756,544,364	2,357,041	1,297,197
Net value	4,975,466,311	-339,616,414	2,341,396	-159,819
Gross cash income	95,703,995		45,037	
Gross home value	4,913,008,279		2,312,004	
Gross returns to land (per ha)	250,366	137,789	118	65
Net returns to land (per ha)	248,705	-16,976	117	-8
Cash returns to land (per ha)	4,784		2	

The financial net returns of crop production are relatively high, at US$117 per cultivated hectare per year on average. The net economic value is strongly negative, however, implying that crop production incurs a national cost of US$8 per ha. In reality, the shadow price of labour may be lower than 15% of the minimum wage rate, and this may mean that the national cost is less.

Value added through processing

A total of 11.7% of households named beer making as a value-added activity. Because this was not asked specifically, it is probable that a greater proportion of households make beer, and a value of 20% of households was used in the model. Beer is made from maize and millet in 210 litre drums, with firewood as an important input into production. It takes about 4 days to make one drum of beer. 94% of the producer households claim to sell beer, at a going price of approximately ZK20 000 per drum. The value added to crop production by beer making is summarised in Table 4.3.4.

Table 4.3.4. Annual values from brewing beer, based on household survey data.

	Z Kwacha		US $	
	Financial	Economic	Financial	Economic
Average per producer household:				
Gross value	57,600	57,600	27.11	27.11
Net value	40,488	32,530	19.05	15.31
Gross cash income	47,000		22.12	
Gross home value	10,600		4.99	
Gross returns to labour (per day)	8,000		3.76	
For whole wetland area:				
Gross value	317,880,889	317,880,889	149,591	149,591
Net value	223,443,775	179,523,232	105,150	84,482
Gross cash income	259,381,975		122,062	
Gross home value	58,498,914		27,529	

4.3.3 Fish

The fisheries sector is one of the most important sectors in the Western Province, and is mainly concentrated on the floodplains of the upper Zambezi (Timberlake 1997, van Gils 1988). Most of the catch in the Western Province is by subsistence farmers in the Barotse floodplain (Simwinji 1997). Fish are an important source of income and protein, and local fish consumption is five times the national average (van Gils 1998). In Lealui, about 75% of people claimed to eat fish at least 3 times per week (village meeting), and the household survey found that 99.3% of households consume fish. Only 25% of the local catch is sold outside the province (van Gils 1988) with 75% of fish being sold locally. There is a high demand for fish in towns, especially the main town centres along the rail line, and in the Copperbelt (D. Kabakwe, Dept. of Fisheries, pers. comm.). A small amount of fish goes to other countries. For example some Tiger fish and bream goes in refrigerated trailers to South Africa. There are no official channels for this trade, however, so the quantities are unknown.

Fisheries research in Zambia has concentrated on the commercial fisheries elsewhere, and there has been little research on the Barotseland fishery (D. Kabakwe, Dept. of Fisheries, pers. comm.). The Barotseland fisheries have been described in the past by Bell-Cross (1971, 1974a) and in various FAO publications (e.g. Kelly 1968).

4.3.3.1 Species, catch methods and seasonality

The only biological survey of the Barotseland fish was carried out from January 1966 to January 1967 by Kelly (1968). A detailed, annotated list of the fish of the Western Province is given in Simwinji 1997. Bream make up 80% of the catch (Maimbo *et al*. 1996). A number of smaller fish are also caught, including minnows, tilapia (cichlids), bottlenose (*Momelops*) and silver barbels (D. Kabakwe, pers. comm.). Between December and April, fish move from the main river channels into the wetlands, where they spawn before the height of the flood (N&K 1997), mostly by about February or March (D. Kabakwe, pers. comm.). As the flood waters rise, a phenomenon called "red water" occurs. Red water is the low oxygen water pushed forward by the floodwater. Only barbel can survive in this water. Thus bream are sometimes killed when red water from the lagoons and channels enters the main channels. Fishing is most effective when the water is receding, and lagoons form in which fish are concentrated (D. Kabakwe, pers. comm.). The highest catches thus occur when the water recedes after April and fish migrate back to the main channels. Fishery productivity is determined by flood levels, as higher floods provide greater opportunities for fish to breed (Nkhata & Kalumiana 1997). Van Gils (1988) relates the fish catch to the length of the flood season.

About 75% of the catch is caught in gill nets, which are set overnight in standing water and lagoons. Ring and draw nets are also used. Gill netting intensifies from May in lagoons and along the edge of the main channel, until December, when many fishermen stop fishing in anticipation of the rains (Chilala 1968). Fish are also caught using traditional *maalelo* traps (a reed and earth weir with conical reed and grass traps; van Gils 1988). This method predominates when the floodplain is fully inundated. Traps and spears are also used during this period (Chilala 1968). Men and women use different traditional fishing methods. Illegal methods, such as fishing with mosquito nets, are also used and are threatening the fishery.

Men, women and children take part in the fishery, although fishers are predominantly men (69%). Women make up a significant proportion (24%) of fishers.

Fishing is strongly seasonal, with fish being scarce during the flood season, and the highest catches being achieved in June and July (village meetings). However, many fishers continue to fish for several months after the peak time (Fig. 4.3.4). There is a closed season from January to March in parts of the study area.

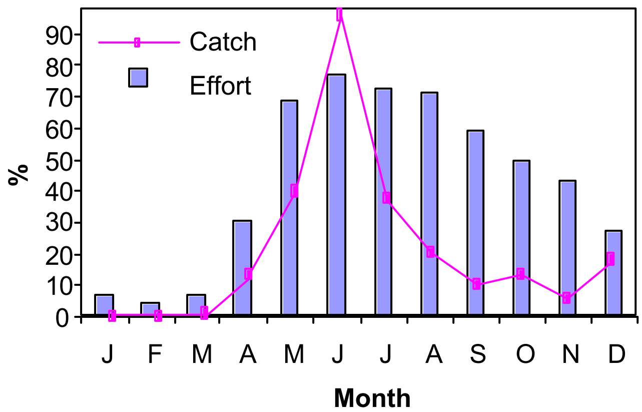


Figure 4.3.4. Seasonal variation in effort (% user households fishing in each month) and perceptions of catch seasonality, given as % relative to the peak catch (based on focus group data).

4.3.3.2 Effort and catch

The collection of annual fisheries catch data for the province is divided into three four-month periods: January - April, May - August and September - December, and into 5 'strata' or geographical areas. Of the 5 areas or 'strata' surveyed in the Upper Zambezi, the first four fall largely within the study area. The following data are collected in each stratum in each period (although the frequency of these surveys is finance-dependent, and data are sometimes only collected for one or two of the periods):
number of fishers
number of boats of different types
fishing camps (villages)
fishing effort over 5 days
gear type & mesh size
catches sampled over 3 days - species, number.

In addition, a Frame Survey is conducted every two years. This is a total census of the fishing community. The data are stored in raw form at the Fisheries Department headquarters in Chilanga, near Lusaka.

According to the 1994 survey, the fishery, which includes all five 'strata', has 2159 fishermen, 3403 boats and 291 fishing villages. The fact that more boats are reported than fishermen puts the credibility of these survey data into question. Average fishing effort in the study area (strata 1 to 4) was 339 days per year. A catch of just under 6000 tons was recorded in the first four strata (Table 4.3.5).

Table 4.3.5. Fisheries data for the Barotse study area per round (four month period) for 1994 and 1995 (Chitembure 1995, 1996).

	Survey round 1. Jan-Apr	2. May-Aug	3. Sep-Dec	Total
1994 CPUE (kg/boat/night)	12.9	26.7	22.2	20.6
1994 Catch (tons)	803.32	2265.34	1659.39	4728.05
1995 Catch (tons)	2407.28	1630.64	1836.33	5874.25

About 60% of households in the Western Province are involved in fishing activities (Simwinji 1997). Within the study area, 54% of households reported that they were involved in fishing, suggesting a fishing population of 14 790 households. This is much greater than the estimates of full time fishers given above, as it includes part-time fishers. Thus most fishermen only fish part time. There was no significant difference in the percentage of fishing households or catch of households categorised in different wealth classes.

Nevertheless, the fishing effort found in this study was similar to the above, with fishing households reporting an effort of around 327 person-days per year, and spending an average of 5.5 hours per fishing trip. However, this effort is often shared among more than one household member. Mean reported household catch was 712kg per year for fishing households. This yields an estimated total catch of 10 530 tons. Thus official estimates probably miss a significant proportion of the catch. This is not an entirely subsistence fishery however: 70% of fishing households claimed to sell part of their catch.

Part of the catch is dried, generally by the fishers themselves, but also to some extent by middlemen. Most fish are sun-dried, but some are smoked using shrubs or leaves. Approximately 3 kg of fresh fish makes 1 kg of dried fish (D. Kabakwe, pers. comm.). Fresh fish prices fluctuate around ZK1000 per kg (Chitembure 1996, this study). Prices for dried fish bundles are given in Table 4.3.6.

Table 4.3.6. Market prices for dried fish in Mongu, March 1998. Bundles are a flat cylindrical shape, and sizes are given as diameter x height.

Type	Bundle size	Price (ZK)
Bream	Small: 20 x 5cm (ca. 6 fish)	3 500
	Medium: 40 x 7 cm	5 000
	Large	10 000
	Very large: 70 x 30 cm (ca. 100 fish)	15 000
Catfish	Smallest: 20 x 5 cm	4 000
	Largest: 70 x 30 cm	11 000

A household subsistence fishery model was developed for Barotseland, based on the reported subsistence fishing, catch and prices, and indicates that subsistence fishers are capable of yielding fairly high returns (Table 4.3.7). This model suggests that, if most of the fishery was part-time, or subsistence in nature, then the annual economic value of the total catch would be in the order of US$4 million, or $3.6 per ha. A greater commercial element in the fishery model would yield a slightly lower overall net value, mainly because costs such as labour and taxes would become more prominent.

Table 4.3.7. Annual values associated with the Barotse fishery, based on a model of a subsistence fishing household, using household survey data (this study).

	Z Kwacha per year		US$ per year	
	Financial	Economic	Financial	Economic
Average per fishing household:				
Gross value	712,000	854,400	335	402
Net value	690,044	659,059	325	310
Gross cash income	208,600		98	
Gross home value	503,400		237	
Gross returns to labour (per day)	3,152		1	
For whole wetland area:				
Gross value	10,530,687,447	12,636,824,936	4,955,618	5,946,741
Net value	10,205,949,534	9,747,679,382	4,802,800	4,587,143
Gross cash income	3,085,254,777		1,451,885	
Gross home value	7,445,432,670		3,503,733	

4.3.3.3 Control of the fishery

As with all natural resources, the fishery is theoretically controlled at a local level by traditional authorities. For example, village *Ndunas* give permission to set up fishing shelters. However, one of the major constraints that has been identified in this fishery is a lack of defined "fishing rights", as well as inadequate infrastructure and facilities (Simwinji 1997). According to Simwinji (1997), the fisheries are essentially open-access. In addition, it was claimed during meetings with villagers that outsiders were entering the fishery at will.

There is a licence system for the fishery. Small scale fishermen pay ZK4700 per year to government and anglers pay about ZK2000. However, there is no penalty for fishing without a licence (D. Kabakwe, pers. comm.). Regulating the fishery through the traditional system is thus preferable, because local penalties are imposed. There are also legal limits on effort and gear. One of the traditional methods, spearing, is illegal. Nets may not have a mesh size under 76mm. However, the transgression penalty of K200 or 6 months in prison plus net confiscation has not been revised since 1974.

A closed season was imposed in 1986 by the government, but was ineffective because the traditional authorities were not consulted. The government is thus now working through the local communities at a district level, and at least two districts (Senanga and Kalabo) have introduced a closed season from 1 December to the end of February.

4.3.3.4 Variability and sustainability

Based on a regression of flood plain area on fish production in African wetlands, total fish production potential in the province is estimated at 12 - 15 000 tonnes annually (van Gils 1988). However, actual fish catches have been considerably less than this. The total catch in Western Province in 1995 was 6 785 tonnes (Chitembura 1996). There has been little development of the industry but production has increased and is increasing relative to other fisheries in the country. The high catches are due to increased fishing pressure and the use of illegal fishing methods. The highest catches are recorded in the area with the highest population (Kalabo and Mongu districts).

At village meetings, villagers claimed that fish catches are highly variable from year to year. They claimed that the drought years over the last 5 - 6 years (up to 1998) had decreased breeding and availability. This was reiterated in the focus groups (Fig. 4.3.5).

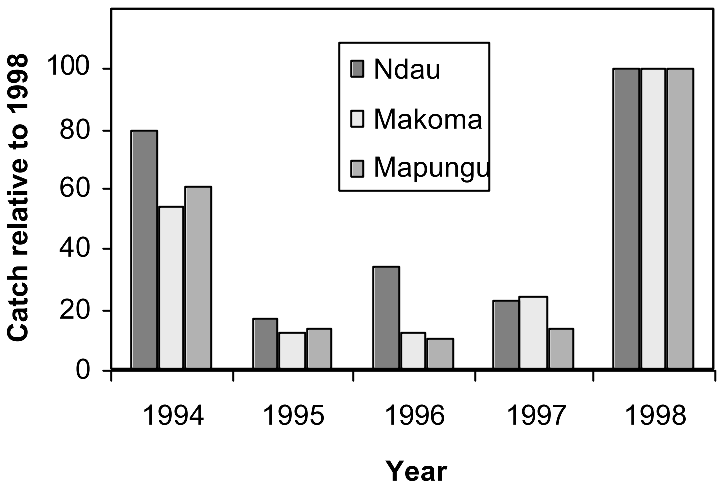


Figure 4.3.5. Perceptions of fish availability over the last five years of fishers in three Barotse villages (focus group data). The three bad years were ascribed to drought conditions.

There was general agreement among fishers that catches have declined markedly over the past four decades (Fig. 4.3.6). Fishers stated that in the 1960s, fishing methods were primitive, in the 1970s, cotton nets came into use, in the 1980s catches increased and fish availability decreased due to human population increase, and in the 1990s the influence of population increase was further exacerbated by "improved" fishing methods.

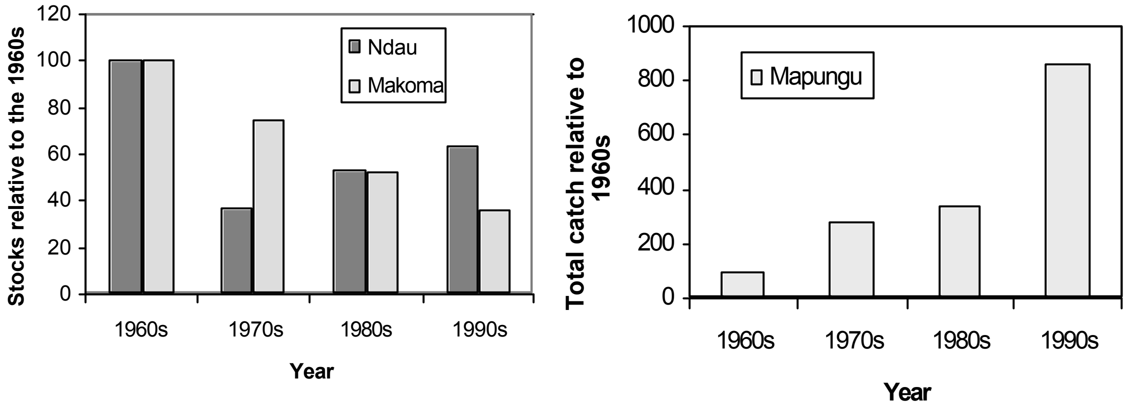


Figure 4.3.6. Perceptions of Barotse fish catches over the last four decades, relative to the 1960s. Two focus groups gave relative abundance of fish, and the third gave their impression of total catches in the wetland.

Residents of Lealui claimed that the local catch was no longer sufficient to feed the village, so people had to buy fish in Mongu. People used to depend more on fish, but this is changing because of decreased availability. According to fishermen, the main reasons for the decline are bad fishing methods and increased effort, due to an influx of outsiders into the fishery. They said that bad methods are being used because its getting increasingly difficult to catch fish. People are reportedly having to use small mesh because there are no big fish left., and are now resorting to using cloth and mosquito nets. Effort is also increasing because more people are turning to fishing because of unemployment. Other fishers are coming in from outside the community (e.g. from Mongu, Lusaka and Angola)., and outsiders are starting to dominate fishing. The fishers also cited problems of transport and communication in marketing fish, and wanted markets out on the floodplain. They said they would like to form a co-operative rather than selling individually.

4.3.4 Wildlife

The only formally protected part of the floodplains is the Liuwa Plain National Park in the north west. This used to be the *Litunga*'s hunting grounds, and was still run by the Barotse Royal Establishment after independence (in 1964) until 1972, when it was taken over by government. People living in the area were not moved, however, and 10 000 people (with 10 420 cattle) live in the park in 108 villages. The Lozi no longer hunt in the park (Mutu KwaWalusiku, Zambian National Parks, pers. comm.).

Many animals are now largely confined to protected areas, especially certain species such as the Red Lechwe and Sitatunga. There has been very little game on the floodplain in the last 40 years (M. KwaWalusiku, pers. comm.). However, crocodiles and hippopotamus are reported to bel common on the floodplain (Simwinji 1997), although this was not substantiated by personal observation, and waterfowl are exceptionally abundant during the flood season (Simwinji 1997). Outside of the protected area many animal populations have been decimated due to poaching and demand for agricultural land. Poaching is particularly problematic, and local inhabitants of the floodplain benefit from poachers based in towns in that they receive bags of maize in return for co-operation (M. KwaWalusiku, pers. comm.). Poachers target birds, including species for the caged bird trade, as well as Lechwe and Reedbuck. Lechwe, in particular, are considered royal game, to be killed only with the *Litunga*'s permission. The species composition of hunted birds has also changed. For example Openbilled Storks are now killed, but were not in the past. There is little poaching of hippos, despite the fact that the meat is a delicacy, because it is too difficult to do clandestinely.

Part of the study area falls within the Game Management Area of Western Province. These are communal lands in which hunting is permitted through a licensing system administered by the National Parks. Licences are issued for different categories of hunters (GMA residents, district residents, residents of other areas, non-residents and safari hunters), with most being issued to non-residents and safari hunters (M. KwaWalusiku, pers. comm.). Four districts operate under the ADMADE system, which together made a small profit of about ZK28 million (US$19 800) over the past year. However, this system is considered too centralised, because nothing can be done without the involvement of the *Litunga*, and there is a problem of distribution of income from this level (M. KwaWalusiku, pers. comm.). While data are available for the numbers of hunting licences issued, there is no data on the level of illegal bushmeat hunting by the local communities or poaching by outsiders, including residents of Mongu and other towns on the floodplain. The only quantitative data on poaching is the number of arrests made, which is in the region of 100 per year. However, this is unlikely to reflect the level of activity as most areas are not well-patrolled (M. KwaWalusiku, pers. comm.).

In village meetings, people claimed that game used to be abundant and an important supply of meat. There were a large variety of species, but now they are harder to find. People would like to have game on the floodplain again, although not an excess. No data was obtained in the household survey on game animals. Men are responsible for all hunting.

Waterbirds such as Cattle Egrets, Great White Egret, Grey Heron, Marabou Stork, Eastern White Pelican and Sacred Ibis are common on the floodplain, but their numbers are unknown. The chicks of many of these species are taken from the nest before fledging during the breeding season (May to July). In the past the royal establishment exercised strict control over this harvest, but no management and conservation measures are being undertaken at present (Simwinji 1997).

According to villagers, a number of bird species are eaten, including geese, Black Storks, Great White Egrets, Ducks, Cormorants and eggs. They are harvested by local residents and people from Mongu who hunt, mainly at night, with traps, spears, sticks and guns. They are mainly taken during the breeding season (when floodwaters are receding). Lealui residents claimed bird catching is rare, but would be more common if it was not forbidden. Villagers also claimed that the availability of birds is decreasing. There used to be a lot of birds when the elders were young. Numbers are dwindling and species are disappearing. This is due to hunting and destroying their natural habitat. The birds breed in the grass, and are being wiped out by early burning which disturbs their breeding habitat. Now people have started to realise that their numbers are going down. An effort used to be made to leave unburnt patches for the birds, but this practice had been neglected in the more recent past. Villagers thought that it would be a good idea to leave important breeding areas aside, and recent efforts to reduce burning has reportedly led to increasing return of birds to their breeding areas (Field Project Officer).

In the household survey, only 2.2% of households claimed to hunt birds, although the true figure is probably higher. Birds are worth approximately K1500 apiece. The value of bird harvesting in the Barotse wetland is summarised in Table 4.3.8.

Table 4.3.8. Annual values of harvesting birds, from Barotse household survey data.

	Z Kwacha Financial	Economic	US $ Financial	Economic
Average per user household:				
Gross value	14,100	14,100	6.64	6.64
Net value	11,884	10,033	5.59	4.72
Gross cash income	990		0.47	
Gross home value	13,110		6.17	
Gross returns to labour (per day)	5,714		2.69	
For whole wetland area:				
Gross value	8,559,605	8,559,605	4,028	4,028
Net value	7,214,064	6,090,615	3,395	2,866
Gross cash	600,994		283	
Gross home value	7,958,612		3,745	

In addition, the villagers claimed to eat turtles which they obtain as a bycatch in their fishing nets. In the household survey, 6% of households claimed to catch turtles. The true figure is likely to be much higher than this, as households were not asked about these resources specifically. Turtles were valued at ZK1500 per animal, but they are generally not sold. The value of turtles is given in Table 4.3.9.

Table 4.3.9. Annual values of turtle harvesting in the Barotse wetland.

	Z Kwacha Financial	Economic	US $ Financial	Economic
Average per user household:				
Gross value	10,200	10,200	4.80	4.80
Net value	10,132	9,453	4.77	4.45
For whole wetland area:				
Gross value	16,887,422	16,887,422	7,947	7,947
Net value	16,775,150	15,649,839	7,894	7,365

The total value of harvesting wildlife is likely to be somewhat greater than the combined values of bird and turtle harvesting given above. However, it is extremely difficult to get at the full value of wildlife harvesting, particularly when some of these activities are illegal.

Local communities come into conflict with birds and at least two game species: hippopotamus and crocodiles. Small passerine birds (different from those hunted) destroy crops. People have to stand in the fields to keep them away. The problem is at its worst in January and February. Hippos graze fields and sometimes block the way when people try to travel by boat to Mongu. Villagers claimed that crocodiles kill 2-3 people every year, as well as livestock, and that they destroy fishing nets. One man claimed to have lost five animals. No-one claimed to hunt hippos., but the villagers expressed that they would like to start a new market for crocodile skins for export.

Crocodile hunting was banned because of its species' listing with CITES. Under these regulations only crocodile farmers can export skins. Thus, the local community can no longer market crocodile skins, with result that there are few people remaining nowadays that would know how to prepare them if the laws were to change. Crocodiles and hippos are killed by local people and the Department of National Parks is also called upon to kill them, but no compensation is paid for deaths caused by these animals.

Villagers did not demonstrate an awareness of the positive values of these animals, such as the value of hippopotami in keeping floodplain water channels open.

4.3.5 Wild plants

4.3.5.1 Reeds

Reeds and sedges are important in rural life on the floodplain. According to villagers, reeds *Phragmites* sp. (*Mataka*) are a fundamental element of building construction, and courtyard fences, mats and some types of fishing apparatus (fish baskets, fish spear handles and fishing rods) are made from reeds. A large house would need 50 bundles of reeds in construction, and lasts about 20 years. Fences last 2 to 5 years.

Reeds are harvested after the floodwaters recede (Fig. 4.3.7).

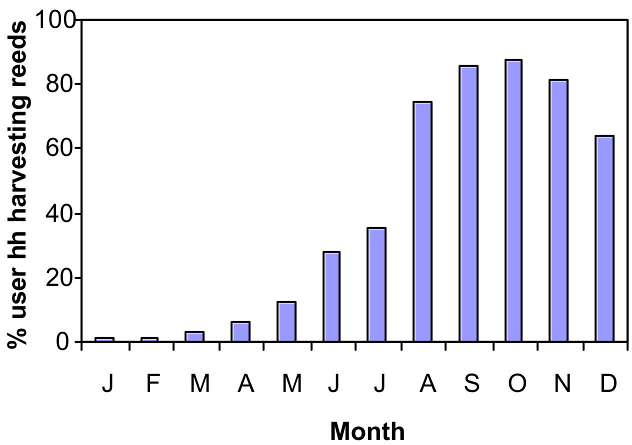


Figure 4.3.7. Percentage of user households harvesting reeds in each month in the Barotse study area (household survey data).

In the household survey, 84% of households claimed to harvest reeds. The average user household harvests 10 bundles per year. Only men harvest reeds. Although there is no difference in the percentage of households of different wealth ranking harvesting reeds, richer households tend to harvest more reeds than poorer households (Fig. 4.3.8).

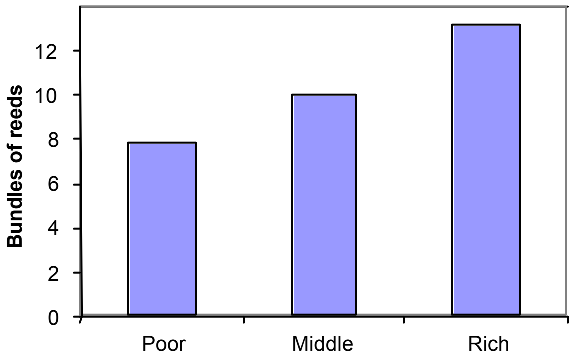


Figure 4.3.8. Average numbers of bundles of reeds harvested by Barotse households of different wealth status (household survey data).

It takes 4.75 hours on average for a harvesting trip, and in most cases, only one bundle is harvested per trip, carried on the head. Reed bundles are worth approximately K1000. Only 5 percent of user households sell part of their harvest. The value of this harvest is summarised in Table 4.3.10.

Table 4.3.10. Annual values of harvested reeds in Barotse wetland

	Z Kwacha		US $	
	Financial	Economic	Financial	Economic
Average per user household:				
Gross value	12,375	14,850	5.82	6.99
Net value	12,001	12,395	5.65	5.83
Gross cash income	469		0.22	
Gross home value	11,906		5.60	
Gross returns to labour (per day)	4,459		2.10	
For whole wetland area:				
Gross value	286,837,833	344,205,400	134,983	161,979
Net value	278,178,035	287,304,693	130,907	135,202
Gross cash income	10,865,069		5,113	
Gross home value	275,972,764		129,870	

Value added through processing

Only 1.5% of household survey respondents named reed mats as a value added activity. Observations suggest that this is probably a gross underestimate, and we assumed in the model that 50% of households are engaged in this activity. Both men and women make reed mats. Producer households made 2 mats per year on average. Mats are worth K2000 Kwacha each, but none of the respondents claimed to sell reed mats. The value added to reeds in mat making is summarised in Table 4.3.11.

Table 4.3.11. Values generated by making reed mats in Barotse wetland

	Z Kwacha Financial	Economic	US$ Financial	Economic
Average per producer household:				
Gross value	4,000	4,800	1.88	2.26
Net value	80	-620	0.04	-0.29
Gross cash income	-		-	
Gross home value	4,000		1.88	
Gross returns to labour (per day)	2,000		0.94	

4.3.5.2 Papyrus

Papyrus *Cyperus* p*apyrus (Mukuma)* is somewhat more valuable than reeds, and has more specialised uses. In particular, they are the preferred material for making sleeping mats. Papyrus is also used for tying in construction, for making waterproof ceilings under thatch, and making coffins. Because this resource occurs higher than reeds, people are still able to access papyrus during the flooded season, and there is less seasonality in the harvest than for reeds (Figure 4.3.9).

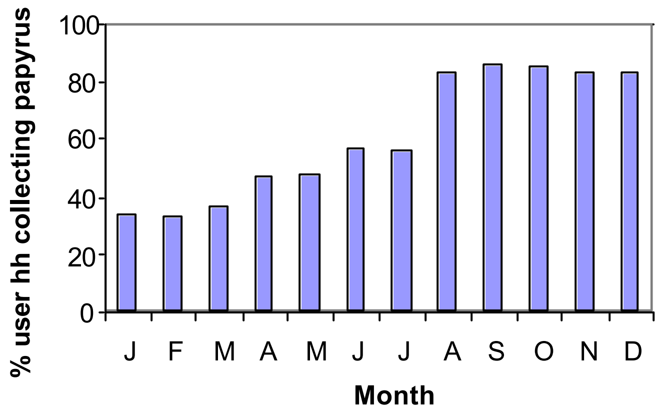


Figure 4.3.9. Seasonal trends in Papyrus harvesting in the Barotse study area (household survey data).

Almost all (93%) of households surveyed harvest papyrus. On average, user households harvest 9 bundles per year, and 12% of user households sell papyrus bundles. Men and women expend equal effort in harvesting papyrus. Unlike with reeds, slightly more poor households harvest papyrus than rich households, and poor households harvest greater quantities on average (Fig. 4.3.10).

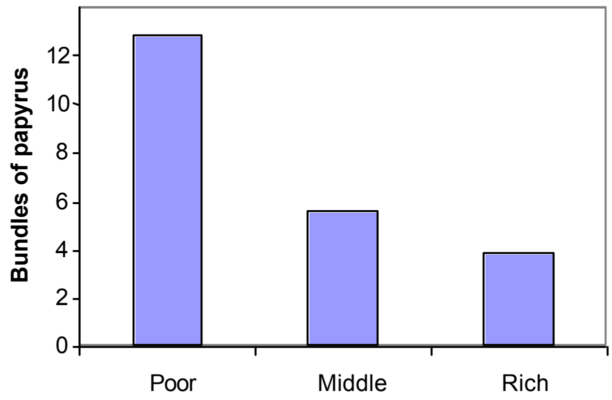


Figure 4.3.10. Average numbers of bundles of papyrus harvested by Barotse households of different wealth status (household survey data).

Papyrus sells for about K1200 per bundle (household survey), and 12% of user households sell part of their harvest. The total value of papyrus harvesting is summarised in Table 4.3.12.

Table 4.3.12. Value of papyrus harvesting in Barotse wetland

	Z Kwacha Financial	Economic	US $ Financial	Economic
Average per user household:				
Gross value	10,824	12,989	5.09	6.11
Net value	10,447	9,237	4.92	4.35
Gross cash income	446		0.21	
Gross home value	10,378		4.88	
Gross returns to labour (per day)	2,405		1.13	
For whole wetland area:				
Gross value	277,768,294	333,321,953	130,714	156,857
Net value	268,099,065	237,042,599	126,164	111,549
Gross cash income	11,455,633		5,391	
Gross home value	266,312,662		125,324	

Value added to papyrus through processing

According to the villagers, everybody makes mats, but only 62% of households surveyed claim to make them, 27% of whom make them to sell. Both men and women make papyrus mats, although women are the main producers. Producer households make an average of 9 mats per year. Mats sell for ZK 1000 - 3000, depending on size and demand and where sold (cheaper locally, more expensive in Mongu and in the uplands). The value added to papyrus in mat making is summarised in Table 4.3.13.

Table 4.3.13. Values generated by making papyrus mats in Barotse

	Z Kwacha Financial	Economic	US $ Financial	Economic
Average per producer household:				
Gross value	15,600	18,720	7.34	8.81
Net value	4,731	3,464	2.23	1.63
Gross cash income	4,212	5,054	1.98	2.38
Gross home value	11,388	13,666	5.36	6.43
Gross returns to labour (per day)	2,667	3,200	1.25	1.51

4.3.5.3 Grass

As well as being used for pasture, grass is used for thatching all houses, tying, weaving, and occasionally for fuel (village meetings). About 200 bundles are used to thatch a roof, although up to 2000 can be used for a big roof. This is replaced every 5 - 10 years, but can last up to 50 years if it is tightly woven. Much thatching grass comes from upland woodlands, and it is unknown what proportion of the grass comes from the floodplain. The harvest of floodplain grasses is highly seasonal (Fig 4.3.11).

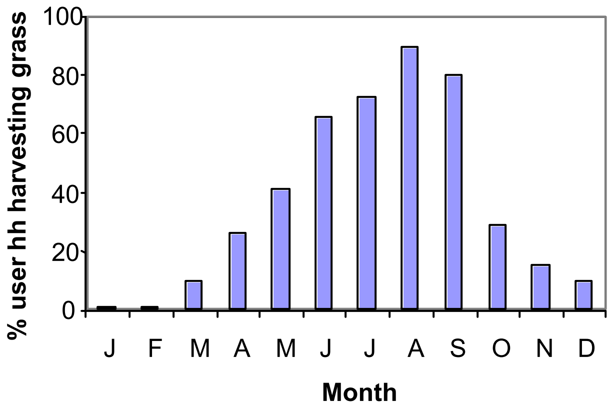


Figure 4.3.11. Seasonality of grass harvesting in the Barotse floodplain (household survey data).

According to the household survey, about 86% of households harvest grass, and user households harvest an average of 16 bundles per year from the floodplain area. Both men and women harvest grass. There was no trend in the amount of grass harvested by households of different wealth status. Three percent of user households sell part of their harvest. Grass generally sells for K1000 to K1500 per bundle (focus groups and village meetings). At least one grass species in the area, *Loudetia simplex* (*Mwange*), is fairly valuable, selling at K2-3500 per bundle (E.Chileshe, in litt.). This grass is used as a fine thatch and for making brooms, and is being heavily exploited for export to Lusaka and Copperbelt. The value of grass harvesting is summarised in Table 4.3.14.

Table 4.3.14. Value of floodplain grass harvesting

	Z Kwacha		US $	
	Financial	Economic	Financial	Economic
Average per user household:				
Gross value	19,875	23,850	9.35	11.22
Net value	19,554	19,414	9.20	9.14
Gross cash income	489		0.23	
Gross home value	19,386		9.12	
Gross returns to labour (per day)	3,622		1.70	
For whole wetland area:				
Gross value	471,647,491	565,976,989	221,952	266,342
Net value	464,036,249	460,699,120	218,370	216,800
Gross cash income	11,613,207		5,465	
Gross home value	460,034,284		216,487	

Value added through processing

About 20% of households make grass brooms, at an average rate of 4.4 per year. Women are responsible for making brooms. 96% of producer households sell their products. The value of this activity is summarised in Table 4.3.15.

Table 4.3.15. Value added to grass by making brooms

	Z Kwacha		US $	
	Financial	Economic	Financial	Economic
Average per producer household:				
Gross value	2,200	2,200	1.04	1.04
Net value	1,650	1,444	0.78	0.68
Gross cash income	1,056		0.50	
Gross home value	1,144		0.54	
Gross returns to labour (per day)	8,000		3.76	
For whole wetland area:				
Gross value	12,141,284	12,141,284	5,714	5,714
Net value	9,105,963	7,967,718	4,285	3,750
Gross cash income	5,827,816		2,743	
Gross home value	6,313,468		2,971	

4.3.5.4 Palms

Villagers in Lealui identified the palm Makulwane as an important wetland resource used for ropes, baskets such as winnowing baskets, and for tying in house and courtyard construction. Both *Borassus* and *Raphia* are used, but neither use nor availability has been quantified (E. Chileshe, in litt.).

There is some seasonality in when palm leaves are harvested (Fig. 4.3.12), although this cannot be explained by flooding except inasmuch as areas are more difficult to travel to during the flooding season, and some people leave the floodplain during this period.

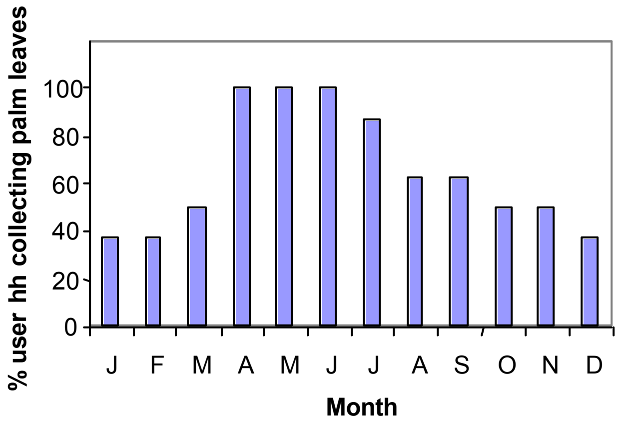


Figure 4.3.12. Seasonality in harvesting palm leaves in the Barotse wetland (household survey data).

In the household survey, 6% of households claimed to harvest palm leaves, although the true value may be higher, as respondents were not asked about this resource specifically. Both men and women harvest this resource. User households harvested 3 bundles per year on average, and none of the respondents sell palm leaves. Poorer user households tend to harvest more than rich households (Fig. 4.3.13). The value of this harvest is summarised in Table 4.3.16.

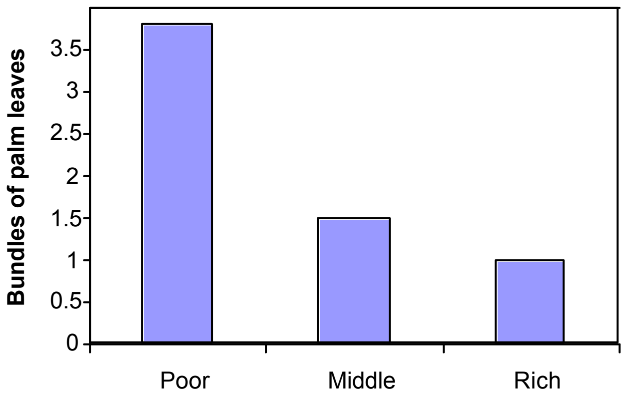


Figure 4.3.13. Average numbers of bundles of palm leaves harvested by Barotse households of different wealth status (household survey data).

Table 4.3.16. Value from harvesting palm leaves

	Z Kwacha Financial	Economic	US $ Financial	Economic
Average per user household:				
Gross value (= home value)	2,880	2,880	1.36	1.36
Net value	2,414	1,253	1.14	0.59
Gross returns to labour (per day)	1,861		0.88	
For whole wetland area:				
Gross value	4,609,273	4,609,273	2,169	2,169
Net value	3,863,267	2,005,754	1,818	944

Value added through processing

Five percent of households claimed to produce baskets, mainly from palm leaves, although some other resources, e.g. grass, were also named. Women make most of the baskets. On average, producer households make 3 baskets per year, and 11% sell their produce. The value added to palm leaves by basket making is summarised in Table 4.3.17.

Table 4.3.17. Value added to palm leaves by basket making.

	Z Kwacha		US $	
	Financial	Economic	Financial	Economic
Average per producer household:				
Gross value	14,880	14,880	7.00	7.00
Net value	8,620	3,563	4.06	1.68
Gross cash income	1,584		0.75	
Gross home value	13,296		6.26	
Gross returns to labour (per day)	2,207		1.04	
For whole wetland area:				
Gross value	20,529,807	20,529,807	9,661	9,661
Net value	11,892,940	4,916,013	5,597	2,313
Gross cash income	2,185,431		1,028	
Gross home value	18,344,376		8,633	

4.3.5.5 Fuel plants

The lack of trees in the Bulozi plain, which normally becomes flooded during the rainy season, presents peculiar fuel problems. Lozi's have thus always used cow dung, crop residues, aquatic weeds (*mambumbwe*), and other vegetation (e.g. *matoya*) to satisfy their energy needs (Macwani 1995). Lealui residnets claimed that it is difficult finding wood for daily use, and that they tend to use reeds instead of wood. Firewood or charcoal is clearly preferred to aquatic plants from the wetland. Villagers claim to collect their own firewood (Table 4.2.15), which comes from upland woodland areas. Nevertheless, firewood sells for about ZK400 for a bundle of 5 pieces (60cm) in the Mongu markets. In addition, charcoal is also sold in the market, presumably from the uplands to the east. The quantities of aquatic plants collected to make up for shortages of fuelwood are unknown.

4.3.5.6 Sustainability of plant resource use

Villagers considered papyrus to be very abundant, but claimed they often have to travel long distances to get to suitable reedbeds. Reeds are also plentiful, but their availability is reduced by early burning for grazing. Villagers perceived a need to manage burning properly. Reeds, papyrus and grass availability is considered to have decreased over the past four decades (Fig. 4.3.14), mainly due to drought, fire, and increasing population. Focus groups claimed there had been no real changes in food or medicinal plant availability, except inasmuch as these are affected by flood levels.

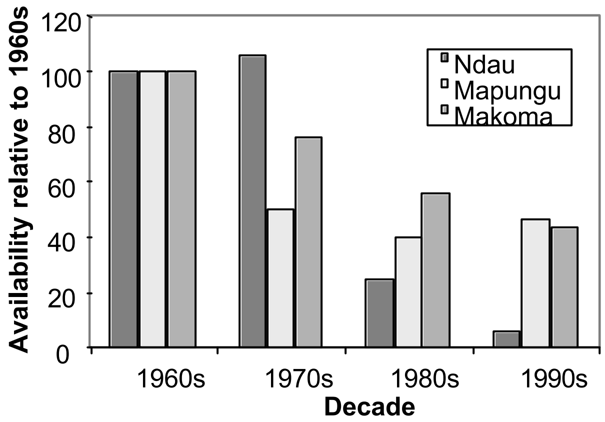


Figure 4.3.14. Villagers' perceptions on the change in availability of reeds, papyrus and grasses over the past four decades (based on focus group discussions in three villages).

4.3.6 Clay

Clay was identified as one of the important resources of the wetland, It is used in house construction and for pottery, and mostly collected during the early rainy season (Fig. 4.3.15).

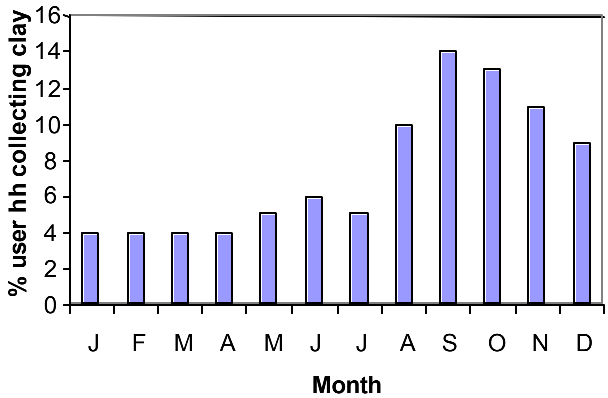


Figure 4.3.15. Seasonality in collecting clay (household survey data).

About 10% of households claimed to harvest clay, with an average of 430 kg collected by a user household per year. Both men and women harvest clay. The value of clay harvesting is summarised in Table 4.3.18.

Table 4.3.18. Value of clay harvesting

	Z Kwacha Financial	Economic	US $ Financial	Economic
Average per user household:				
Gross value (= home value)	43,330	43,330	20.39	20.39
Net value	43,097	35,095	20.28	16.52
Gross returns to labour (per day)	4,061	4,061	1.91	1.91
For whole wetland area:				
Gross value	121,955,334	121,955,334	57,391	57,391
Net value	121,300,431	98,776,831	57,083	46,483

Value added through processing

According to villagers, pottery appears to be a thing of the past. Only women make pots. Villagers claimed that most people who used to make pots have died, and only about 6 villagers in Ndau make pots, for sale. However, the market for pots was reportedly good. The value of making clay pots is summarised in Table 4.3.19.

Table 4.3.19. Value added by making clay pots

	Z Kwacha Financial	Economic	US $ Financial	Economic
Average per producer household:				
Gross value	6,600	6,600	3.11	3.11
Net value	5,610	4,063	2.64	1.91
Gross cash income	400		0.19	
Gross home value	6,200		2.92	
Gross returns to labour (per day)	3,200		1.51	
For whole wetland area:				
Gross value	18,211,926	18,211,926	8,570	8,570
Net value	15,480,137	11,211,717	7,285	5,276
Gross cash income	1,103,753		519	
Gross home value	17,108,173		8,051	

4.3.7 Tourism

There is currently very little tourism in the area; even in the Liuwa Plains National Park to the west of the study area, where there are camping facilities. The only resort in the study area is the Senanga Safari Lodge in the south, but two more fishing lodges are planned for the area (D. Kamweneshe, pers. comm.).

4.3.8 Overall annual use value and local perceptions

Households perceived crops to be by far their most important source of income (including non-cash income). Fish and other wetland resources were perceived to be of similar value, and together are perceived to contribute more value than generated by crops. Upland resources are also significant in terms of their perceived value, and as with other natural resources, were assigned more value than cattle. Cash income from jobs is small, but not insignificant in comparison with other values (Fig. 4.3.16).

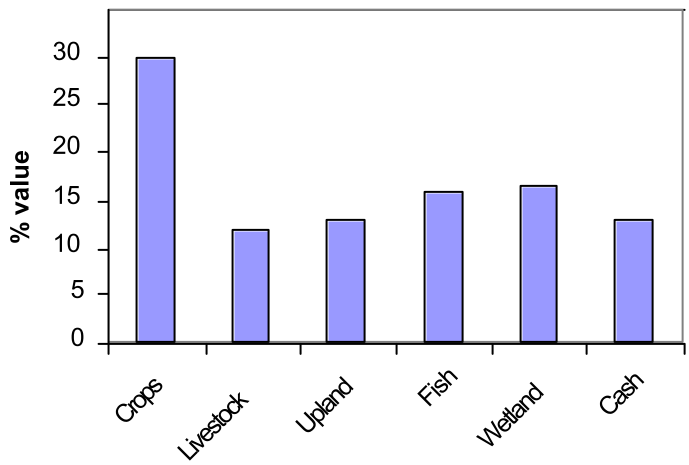


Figure 4.3.16. Mean perceptions of relative Barotse income (including non-cash income) from different resources (household survey data).

According to this study, the value of crops is outweighed by fish and cattle, with fish generating the greatest value to an average household (Table 4.3.20). Other resources each contribute relatively little to the average household per year, but added up, they account for a gross financial value of US$735 000 to households annually. Fisheries contribute 73% of cash income, and other natural wetland resources account for 2.7%. In all the wetland is estimated to be worth approximately US$12 million annually to the economy in terms of its gross use value, with a net economic value of US$8.6 million.

Cash income from natural resources is currently fairly small, with households making just over US$50 per year from selling harvested resources and crafts. However, recent initiatives in the Barotse Floodplain area are starting to have an impact on this income. The ZBWCRUP project has sponsored two courses in crafts production, working closely with the non-profit Mumwa Crafts association in Mongu to promote the production of high quality crafts which have the potential to reach international markets. The success of one village has already started to motivate others: this community has earned about US$4000 since January 1999. Although the products are made from a variety of resources, including timber, tree roots and sisal, at least a portion of this production can be attributed to wetland resources.

Values obtained in this study were spread somewhat differently among different resources than the perceptions of this distribution (Fig. 4.3.12). Crops and wetland resources are worth less than generally perceived, and fish and cattle resources are worth more. The high perceived value of crops is probably linked to their food security value, as crops are the most important resource for survival, and a high perceived value of wetland resources may be linked to their important utility value.

Table 4.3.20. Summary of current consumptive use values of the Barotse wetland

BAROTSE	Cattle	Crops	Fish	Ani-mals	Reeds & papyrus	Palms	Grass	Clay	TOTAL
Average wetland hh (US$/y)									
Gross financial value	120.4	90.8	179.6	5.83	15.12	0.43	8.25	2.39	417
Net financial value	120.4	88.7	174.1	0.41	10.72	0.27	8.07	2.33	405
Gross cash income	11.5	6.1	52.6	0.01	1.61	0.04	0.30	0.02	72
Gross home value	109.0	84.8	127.0	0.42	13.51	0.39	7.95	2.37	345
Total wetland (US$ '000s/y)									
Gross economic value	3,988	1,447	5,947	12	501	12	272	66	12,244
Net economic value	3,908	-75	4,258	10	271	3	221	52	8,647
Gross financial value	3,323	2,507	4,956	12	417	12	228	66	11,520
Net financial value	3,323	2,447	4,803	11	296	7	223	64	11,174
Cash income	316	167	1,452	0.3	44	1	8	0.5	1,989
Gross home value	3,007	2,340	3,504	12	373	11	219	65	9,531

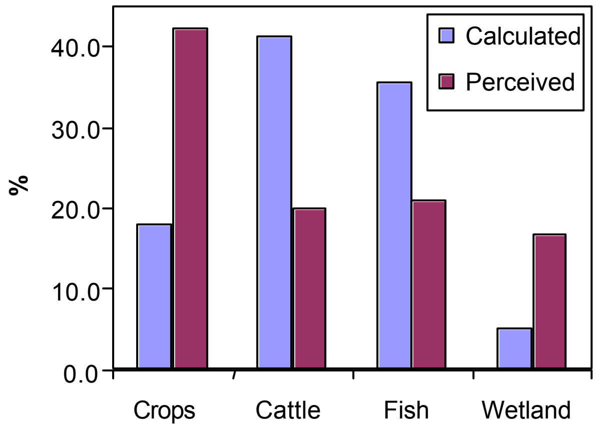


Figure 4.3.17. Relative measured value of crops, cattle, fish and wetland resources in Barotse wetland obtained in this study, vs their relative perceived value.

4.4 THE CHOBE-CAPRIVI WETLANDS

4.4.1 Livestock

In Caprivi, cattle are prized more for their social value in giving herd owners security, rights to land and status than they are for their tangible benefits (Mendelsohn & Roberts 1997). Meeting these goals, as well as basic needs (meat, milk, draught power), is more important to rural Caprivians than maximising herd off-take and profits as in commercial cattle farming (Ashley & LaFranchi 1994). Small stock is not important in eastern Caprivi, with some 30% of households owning a few goats (Paskin & Hoffmann 1995). While most households do own chickens or other domestic fowl, they are valued only as a source of protein and bring in small amounts of income (Paskin and Hoffman 1995, Mendelsohn & Roberts 1997).

There is a limited amount of transhumance along the margins of the floodplains (Paskin & Hoffmann 1995). During peak flooded periods (March-June), about 37% of cattle are moved off the floodplains and into the upland woodlands (Paskin & Hoffmann 1995, *kuta* senior headmen: pers comm., focus groups). In return, some upland villages have grazing privileges on the floodplains during summer (*kuta* senior headman: pers comm.). Hired herders, often children, do most of the herding and are usually responsible for milking (Paskin & Hoffmann 1995, household surveys). In Caprivi, most of this labour comes from Zambia. Grazing is generally away from the villages in order to prevent crop damage and there is some grazing on stovers after crop harvesting (Paskin & Hoffmann 1995).

There are reportedly about 124 000 cattle in eastern Caprivi, primarily concentrated on the floodplain grasslands, where grazing is moderate to good (Mendelsohn & Roberts 1997). According to the same source, there are 57 234 head of cattle within the boundaries of Kabe (Mendelsohn & Roberts: GIS data). In this study, the household survey found that 87% of households in the study area own an average of 22 cattle. Based on these survey data, we estimate that a total of 86 580 cattle are grazed on the floodplain during the non-flood season. The household survey found a herd composition similar to that reported by Paskin and Hoffmann (1995, Table 4.4.1). The survey also found that, on average, annual sales and home consumption proportions were similar to those reported in the literature (Table 4.4.1).

A total of 55% of all cows were reported to be milking cows, producing an average of 1.3 litres of milk per day. This yields an estimate of 261 litres of milk per cow (all cows) per year. This is similar to Paskin & Hoffmann (1995) who report that milk production in the Caprivi is 4 - 5 litres per milking cow per day in the wet season and <1 litre per day during the dry season. About 94% of households use hired herdboys, at an average wage of a little over N$3 per day.

Table 4.4.1. Herd composition, sales offtake and home consumption in the study area (source: household surveys, Paskin & Hoffmann 1995, Ashley & LaFranchi 1997)

Herd composition	Household survey	Paskin & Hoffman	Ashley & LeFranchi
Bulls	11%	3%	
Cows	47%	49%	
Female & Male calves	10%	14%	
Heifers & Steers 1-2 years	10%	12%	
Oxen	22%	22%	
	100%	100%	
Sales offtake	3.5%	4.4%	
Home consumption	2.1%		1.5%

The average selling price for a head of cattle was conservatively taken as N$712 (Kirsten *et. al.* 1999). This falls within the range of N$700-1200 obtained from focus group discussions, and agrees with Ashley & LaFranchi (1997) who give a range of N$200-1100 for the value of a cow "on the hoof". The value of grazing in the study area was taken to be the productivity of cattle during the months they spend within the floodplain area, including the value of milk production. Manure does accumulate in cattle crushpens, but on the floodplains is apparently rarely used as a fertiliser (Paskin & Hoffmann 1995, household surveys) and is excluded from the Caprivi model. Results are summarised in Table 4.4.2.

Table 4.4.2. Annual values associated with cattle grazing on the Chobe-Caprivi floodplain, based on household survey and focus group data

	Namibian $		US $	
	Financial	Economic	Financial	Economic
Average per cattle-owning household:				
Gross value	2,910	3,085	485	514
Net value	2,910	2,741	485	456
Gross cash income	377		63	
Gross home value	2533		422	
Gross returns to labour (per day)	7.97		1.33	
For whole wetland area:				
Gross value	11,665,629	12,365,567	1,944,272	2,060,928
Net value	1,665,629	10,985,767	1,944,272	1,830,961
Gross cash income	1,512,958		252,160	
Gross home value	10,152,671		1,692,112	
Gross returns to land (per ha)	75.75	80.30	12.63	13.38
Cash returns to land (per ha)	9.82		1.64	

There is some use of manure as a building material and for fuel (Ashley & LaFranchi 1997), but this was not quantified. In addition, ox ploughing is the main soil preparation method. (Paskin & Hoffmann 1995) with about 80% of fields being prepared this way (Mendelsohn & Roberts 1997, Ashley & LaFranchi 1997). Not everyone owns trained oxen and teams of six to eight oxen are usually borrowed during the cultivation season. The costs of ploughing with a tractor are N$80 (US$13) per day, covering 4 ha. Assuming oxen are used to plough 80% of the fields in the study area, this amounts to a savings of about US$60 000 to rural households. In addition, long-distance transport provided by oxen through the use of sleds (timber, fuelwood, reeds, grass and water) has a significant value to rural households (Ashley & LaFranchi 1997). The latter values were not included in the model, however, due to lack of empirical data.

The annual growth of the eastern Caprivi herd is leading to an annual increase in crop production (Ashley & LaFranchi 1997). The values of livestock and crops systems are intricately linked through transfers of manure, stovers, draught power and cash from one to the other. Ashley & LaFranchi (1997) report that households with 11 or more cattle have 2-3 times higher crop production than those with no cattle. This interaction needs to be investigated quantitatively in order to generate more accurate estimates of net value for both grazing and cropping.

These direct use values capture only the market value of the tangible benefits from cattle ownership and production. The following intangible, cultural benefits to cattle ownership are not captured in this study and are likely to be significant (from Ashley & LaFranchi 1997):

Gifts and reciprocal exchange - wedding and funeral gifts, the familial sharing of draught oxen teams, calves received for herd tending and/or work,

Store of wealth - investment in a herd which "grows" at an interest rate in excess of formal banking, although at higher risk, and can be converted to cash relatively easily and locally,

Drought-coping strategy – cattle can be sold to buy staple grains in poor years,

Ceremonial uses and cultural assets – a brideprice (*lobola*) is traditionally paid in cattle; cattle are also assets of community participation, playing a role in births, funerals and marriages, allowing community members to conform to cultural traditions, and

The 'right to avail' – maintaining livestock in a home area helps maintain membership of a community and the right to avail of its resource.

Finally, another area where value may have been underestimated in the model is in the use of prevailing market prices for cattle. It costs about N$1000 (US$167/child/year) to go to secondary school, which is usually paid for by selling cattle (*kuta* senior headman: pers. comm.). Since most marketing takes place early during the year to cover annual school fees and annual clothing needs (Ashley & LaFranchi 1997, Paskin & Hoffmann 1995), over-supply to local markets with limited demand leads to depressed prices. Commercial buyers exploit the situation by tracking low local market prices (*kuta* senior headman: pers. comm.).

4.4.1.1 <u>Sustainability of cattle production</u>

Cattle densities in some local areas approach 60 cattle per km^2. Such stocking rates are about four times in excess of suggested suitable rates for the region and suggests that the patches of highly nutritious grass along the floodplain drainage lines may be under extreme pressure (Mendelsohn & Roberts 1997). Despite this pressure, most people in the region indicate a desire to increase their herd size (Paskin & Hoffmann 1995) and cattle are perceived as the primary wealth store (rural banking system) (*kuta* senior headmen: pers. comm.) In many instances, poor families may tend herds for rich families and receive some calves in payment (Paskin & Hoffmann 1995). The Bukalo *kuta* supports this cultural system by indicating that there will never be a limit imposed upon herd size as each man should have a herd of several cattle in order to provide for his family (*kuta* senior headmen: pers comm.).

Some issues were raised by *kuta* senior headmen which need further investigation. An adequate water supply is a problem in some villages and many cattle die during drought years. Upland villages that receive cattle during the flood periods require more boreholes. There is also not enough grass around upland villages during drought years and some areas are becoming degraded.

4.4.2 Crops

The main crops grown in the eastern Caprivi region include maize, millet, sorghum, melons, groundnuts, pumpkins and vegetables (Paskin & Hoffmann 1995, Mendelsohn & Roberts 1997). Rural subsistence cultivation is characterised by low inputs and low outputs i.e. little investment in fields, labour and seed leading to low harvest yields (Mendelsohn & Roberts 1997, Ashley & LaFranchi 1997). Yields tend to be both low and highly variable due to rainfall variation and pest outbreaks (Mendelsohn & Roberts 1997, Ashley & LaFranchi 1997)

The predominantly clay-loam soils of the Caprivi floodplains, combined with a favourable flooding regime and good nutrient balance, provide moderate to good soils for crop cultivation throughout the constituency (Mendelsohn & Roberts 1997). Old drainage meanders within the large zone of clay-loam provide rich soils, known as *sitapa*, on which much of the constituency's maize crop is grown (Mendelsohn & Roberts 1997). Maize requires more water than the other staple grains and is thus more predominant in the wetter floodplains where it is usually planted as the water recedes (Ashley & LaFranchi, 1997). Millet and sorghum are also usually planted by households as a mechanism to spread risk in drier years, as these crops are more drought resistant (*kuta* senior headmen pers. comm., Ashley & LaFranchi, 1997).

Almost all (98%) respondents of the household survey are engaged in subsistence farming. The average area cultivated per household is 4.43 ha, suggesting that some 20 000 ha, or 6.6% of the study area, is planted under crops. These figures compare favourably with the average of 3-4 ha per household reported in the literature (Paskin & Hoffmann 1995, Mendelsohn & Roberts 1997, Ashley & LaFranchi 1997, DEA Namibia), and the approximately 8% of Kabe planted in the 1994/5 season (Mendelsohn & Roberts 1997).

Ashley & LaFranchi (1997) report a range of grain crop yields of 30 - 700 kg/ha for the entire Caprivi region, depending on a variety of soil, moisture and climatic factors. The Ministry of Agriculture, Water and Rural Development in Katima Mulilo provided an estimated official figure of about 1000 kg/ha for floodplain maize yields. The actual crop yields obtained in the household survey were extremely poor, primarily because the 98/99 crop season was a poor crop year in Caprivi in general. The total maize yield for Caprivi in 98/99 was 3 300 tons, while the average for the nine years between 90/91 and 98/99 was 7200 tons. Total yields ranged from 1500 to 14 600 tons in this period (M. Fowler, Senior Advisor, Directorate of Planning, Min. of Agriculture, Water and Rural Development, Namibia, pers. comm.). Using this information, we multiplied the yields obtained in the household survey by a factor of 2.18 to bring them in line with an "average" Caprivi crop year. The main crops grown in the study area, mean field size, total area, and their reported yields and prices are listed in Table 4.4.3. The ratio of maize to millet found in this study is similar to that found in the Caprivi region as a whole (Mendelsohn & Roberts 1997). However, whereas sorghum makes up 27% of crop area in the region, it was not reported in the study area, probably because it tends to be grown more in upland regions.

Table 4.4.3. The main crops grown in the Chobe-Caprivi study area, mean field size, total area, and their reported yields and prices (household survey data).

Crop	% farmers	Mean area per hh (ha)	Total area (ha)	% area	Yield (kg/ha)	Price/kg (1999 N$)
Maize	100	3.1	14 040	70	368.9[1]	0.75[2]
Millet	59	2.7	6 020	30	428.8[1]	0.75
TOTAL			20 060			

[1]adjusted up by a factor of 2.11 to reflect long-term average years
[2]Mill price in Katima Mulilo

Data on sales prices for both grains were similar, ranging from N$0.44-1.50/kg (hh surveys and focus groups). Household labour on crop production annually was approximately 6 700 hours, as estimated from focus group crop/effort calendars. This equates to similar labour hours per hectare per year as the figure for the Barotse wetlands. Costs of fertiliser were excluded from the model (see previous section on livestock). The value of agricultural production on the Chobe-Caprivi floodplains is summarised in Table 4.4.4.

Table 4.4.4. Annual values associated with the cultivation of the Chobe-Caprivi floodplain, based on household survey data

	Namibian $ Financial	Economic	US $ Financial	Economic
Average per household in wetland:				
Gross value	1,263	928	210.57	154.73
Net value	1,231	-5,160	205.23	-859.93
Gross cash income	14		2.40	
Gross home value	1,249		208.17	
For whole wetland area:				
Gross value	5,820,971	4,277,336	970,162	712,889
Net value	5,673,415	-23,772,183	945,569	-3,962,030
Gross cash income	66,256		11,043	
Gross home value	5,754,716		959,119	
Gross returns to land (per ha)	291.01	213.84	49	36
Net returns to land (per ha)	283.64	-1188.46	47	-198
Cash returns to land (per ha)	3.31		1	

The market prices applied to total crop production in each case were set at the local market, or "farm-gate" price. Since, a fair proportion of crops are sold at prices significantly higher that the Katima Mill price of N$0.75, especially during times of shortage before harvest (focus groups), the value of crop production in the study area is conservative. The primary limitation of the crop model, however, is that it includes only the two crops for which quantitative data were obtained in the household survey. The average net financial return of US$47 per cultivated hectare per year is subsequently low. Data from the focus groups indicates that many households also grow sorghum, vegetables, potatoes and usually intercrop their grains with beans and other legumes. Were these to be included in the model, they would most likely add a further 30-40% to the values associated with crop production as is the case in the Barotse wetland (Table 4.3.2).

The large negative net economic value of approximately US$4 million implies that cultivation of the Chobe-Caprivi wetlands incurs an economic cost to Namibia of US$198 per hectare. This is primarily due to the significant cost of labour time, despite being shadow priced at 35% of the national minimum wage rate. Ashley & LaFranchi (1997), reported that casual labour, employed by households to "clear or plough land, herd cattle, building and repairing houses, domestic work and assisting in shops was paid N$5 to 10 per day. This is similar to the shadow wage rate used in this study. In reality, due to the food security and tenure issues mentioned under the limitations section below, combined with lack of job opportunities, the shadow price of labour may be closer to zero in the study area, in which case the net economic value would become weakly positive. Poor yields, despite being adjusted, also contributed to low values.

4.4.2.1 Value added through processing

The above values exclude value generated by crop production through uses other than sale or staple food consumption. Beer brewing from grains adds both market and social values to the crop. A survey in the Kavango district reported that in about 20% of households women were brewing and selling beer, earning monthly incomes of N$30-90 (Naeraa *et al*. 1993 cited in Ashley & LaFranchi, 1997). According to the household survey, 18% of all households make beer for both social occasions and sale. Brewing is exclusively by women. This activity adds an additional 20% to net crop value for those households that brew, but more importantly, generates a significant amount of cash income (Table 4.4.5).

Table 4.4.5. Annual values associated with brewing beer, based on household survey data

	Namibian $		US $	
	Financial	Economic	Financial	Economic
Average per producer household:				
Gross value	293	293	49	49
Net value	256	172	43	29
Gross cash income	291		48	
Gross home value	1.66		0.28	
Gross returns to labour (per day)	26.29		4.38	
For whole wetland:				
Gross value	242,629	241,255	40,438	40,209
Net value	211,943	141,283	35,324	23,547
Gross cash income	241,255		40,209	
Gross home value	-		-	

Crop sales provide the primary form of annual cash income for many rural households (Ashley & LaFranchi 1997). Surplus maize from the study area is often sold to the mill in Katima Mulilo or sold and bartered outside the study area (focus groups). The importance of this becomes apparent when one takes into account that most of Caprivi has a staple grain shortage of 32% in average years to as much as 80% in poor years (Ashley & LaFranchi, 1997). With its higher proportion of maize and better yields, the eastern Chobe-Caprivi floodplain provides food security to the adjacent rural regions, especially in average years when floodplain yields are likely to be significantly relatively higher than yields on the drier uplands. This contribution to regional food security by the floodplains has an important social value, aiding in the maintenance of regional population carrying capacity and the host of economic activities that they engage in.

4.4.2.2 Sustainability of crop production

Dry upland areas are more likely to be severely affected by crop failures in dry years than the wetter floodplains. Although headmen interviewed in the Kabe constituency had experienced poor crop years, most reported that they usually produced sufficient grain to feed their households. According to Ashley

& LaFranchi (1997), this is about 1095 kg/hh/y, which works out to about 250 kg/ha/y in the study area, less than reported yields. However, it should be noted that the population in Caprivi is now 18 times what is was a 100 years ago, and it is still growing. The clearing of land for cultivation has perhaps had the greatest and most visible impact on the environment in Caprivi (Mendelsohn & Roberts 1997). When fields are considered no longer as fertile as they could be, or when households increase their resource base, new fields are cleared. The mean rate of increase in total cleared area in eastern Caprivi since 1943 has been 4.1%, which is similar to the population growth rate (Mendelsohn & Roberts 1997). Such expansion cannot continue indefinitely, and clashes with the livestock and wildlife tourism sectors will become more frequent.

4.4.3 Fish

Between 59 and 74 fish species are recorded for the Chobe-Caprivi region, with only one being endemic (Van der Waal & Skelton 1984, Bethune & Roberts 1991, Holtzhausen 1991, Timberlake 1997). Fish are a major resource in Caprivi, both in providing food and income for many people and for recreational angling (Mendelsohn & Roberts 1997, Timberlake 1997). According to a common saying, "if you don't fish you are not a Caprivian" (Tvedten *et al*. 1994). Most fishermen in the area belong to the traditionally floodplain living and fishing Subia tribe. Households in the study area eat fish daily for most of the year, and fish is ranked over beef, game and poultry as by far the most important source of protein (focus groups).

4.4.3.1 <u>Species and fishing methods</u>

In the 1970s, commercial catches were dominated by large cichlids, e.g. *Oreochromis andersonii* (*Njinji*) and *O. machrochir (Muu)*, as well as *Serranochromis* species (*Njenga)* and *Clarias gariepinus* (*Ndombe*). Experimental catches in 1980 were dominated by Purpleface largemouth *Serranochromis macrocephalus*, Sharptooth catfish *C. gariepinus* and Silver catfish *Schilbe mystis (Lubango)* (van der Waal 1990). According to the focus groups, current catches by floodplain fishermen comprise the same range of species, with *Oreochromis, Serranochromis* and *Clarias* dominating by weight. All species are caught in the main channels, as well as on the floodplain during the flood months (focus groups).

Gill nets are the most common fishing gear among fishermen with 98% of fishing households reportedly using an average of 4 nets at any one time. Tvedten *et al*. (1994) found that 50% of fishing households were using an average of 3-5 nets, while in 1980 the ratio of gill nets to fishermen was 2.9, of which 66% were bought and the remainder self-made (van der Waal 1990). The average price of a 50 yard gill net ranges between N$20 and N$100 depending on quality (Tvedten *et al*. 1994, focus groups).

Dragnets (*lituwa*) are the second most common gear, used by 18% of fishing households according to Tvedten *et al*. (1994). Dragnets are about 100-300m, and made of various materials, including connected gill nets, and cost N$500 - 1000. No empirical data was collected on their use in the household survey

Hooks and lines are used throughout the floodplain, usually by young boys.

Many fishermen owning nets also use traditional gear, employing a variety of traps, fences and funnels. These "traditional" fishing methods catch a broader suite of species than the conventional fishery (54 species *vs* 21 species; van der Waal 1990). Fences trap fish returning to the river as the floodwaters subside. Peculiar specialised funnels are used in the rapids at Impalila Island to catch Tigerfish. Multibarbed fish spears are used by some fishers, and push baskets and draw baskets are also used in pools. The traditional fishing methods are probably completely complementary to the conventional fishery, catching predominantly small species and only small numbers of the juveniles of larger species (van der Waal 1990, focus groups).

About 87% of fishermen use dug-out canoes (*mikoro*), of which 67% own them (Tvedten *et al*. 1994). These are mostly made from Kiaat *Pterocarpus angolensis* and Rhodesian Teak *Baikiaea plurijuga* (van der Waal 1990), cost approximately N$400 (Tvedten *et al*. 1994) and are replaced every 4-6 years.

4.4.3.2 Seasonality, effort and catch

The most prominent feature of fish populations in the Caprivi is their dynamic nature, responding to the seasonal fluctuations in water levels. As the river rises, deoxygenated 'red water' flushed from ponds and dambos brings abundant barbel to the floodplain. This is followed by 'white water', which is rich in bream. As the floodwaters subside and shallow pools form, the catch becomes dominated once again by barbel (focus groups). Fish move onto the floodplain as the water rises in order to breed. Many small fish species are caught in areas of aquatic plants, and green-headed and three-spot bream (*Tilapia* species) are caught in areas of flooded hippo grass (village meetings, focus groups).

Fishing in the study area is only slightly seasonal, with almost all fishing households actively fishing in the flood season and for several months after (February to October). During the low-water period (November to January), fishing is confined to the Zambezi and Chobe Rivers and the permanent canals (*kasayas*) that cross the study area, forming refuges for fish during the dry period (van der Waal 1990, focus groups). During this period, some 80% of fishing households still fish at least occasionally (household surveys). Some 40% of the total annual catch in the study area comes from the Zambezi and Chobe main channels, while the remaining 60% comes from the floodplain (household surveys). Fish caught during the flood period are often dried and marketed later during the year.

Previous estimates of the total amount of fishing in the area vary greatly. In 1980 it was estimated that there are more than 340 fishermen in the on the Zambezi and associated floodplain (van der Waal 1990). While the majority of fishers had been fishing in the area for over 20 years, there was evidence of a new 'cohort' of fishers emerging, as a large percentage had fished for less than 5 years (van der Waal 1990). A more recent survey estimated that 50% of households in the Kabe/Katima Mulilo districts are involved in fishing on a full-time, part-time or occasional basis (Tvedten *et al*. 1994). Within these fishing households, 32% (2.2) of the average of 6.9 members fish (Tvedten *et al*. 1994). Fishing by women is frowned upon and women are generally excluded from full-time fishing. Less than 4% of households surveyed had women fishing, which agrees with Tvedten *et al*. (1994) who found that only 5.8 % of female-headed households are involved in fishing.

This study found that 75% of all households in the study area are engaged in subsistence fishing, averaging 760 fishing-hours per household per year. Mean reported household catch was 370kg per year for fishing households. This yields a total catch of about 1 279 tons for the study area. Some 64% of fishing households sell an average 10% of their catch for cash income. Prices of fresh and dried fish fluctuate between N$4-10 per kg, depending on the species, season and market. A household subsistence fishery model was developed for the Chobe-Caprivi study area, based on the reported catch, price and input data. The results of the model, given in Table 4.4.6, indicate that subsistence fishing yields high values to wetland households. However, some inputs, such as dragnets and spears, are not included in the model as no empirical data was reported in the household survey.

Table 4.4.6. Annual values associated with the Chobe-Caprivi fishery, based on a model of a subsistence fishing household, using household survey data

	Namibian $		US$	
	Financial	Economic	Financial	Economic
Average per user household:				
Gross value	2,590	2,745	432	458
Net value	1,796	1,206	299	201
Gross cash income	187		31	
Gross home value	2,403		401	
Gross returns to labour (per day)	27		5	
For whole wetland area:				
Gross value	8,949,845	9,486,835	1,491,641	1,581,139
Net value	6,205,708	4,166,491	1,034,285	694,415
Gross cash income	645,240		107,540	
Gross home value	8,304,604		1,384,101	

The value of recreational angling is not measured in the use value model, and it could add significantly to the overall wetland value of the fishery. An element of this value is captured in tourism value associated with lodges (see below under tourism). In addition, the value of the "commercial fishery" is not completely captured in this use value model. While it is true that some of the households in the survey are fishing commercially and are included, there is a formal commercial sector based in Katima Mulilo and Kasane that operates within the study area, especially on the main river channels. Empirical data for this commercial fishery is not available. However, based on estimates of fishing effort in Tvedten *et al*. (1994) and of CPUE in van der Waal (1990) and Tvedten *et al*. (1994), catches could be as high as 3 tons per boat per annum for operations working out of Katima Mulilo.

4.4.3.3 Availability and sustainability of fishing

Fish catches in the whole of the Caprivi have declined markedly since the 1980s. This is partly due to the drying up of Lake Liambezi in 1985-6, which was the major source of fish in the region, and partly to the clogging up of parts of the Kwando-Linyanti system (Tvedten *et al.* 1994, Day 1997). Now that fishing is most important along the Zambezi and Chobe Rivers and the eastern floodplain, there is increasing commercialisation and pressure on fishery resources in the region (Tvedten *et al*. 1994).

Van der Waal (1990) estimated the 1980 catch for the whole of the Caprivi at 1 500 tons, with about 500 tons of this comprising the gill net catch in the Kabe constituency. The Government estimated an MSY of 400 tons for the eastern floodplains and 300 tons for the Zambezi River, which together comprise 70% of the study area (Tvedten *et al*. 1994). It was estimated that the total fish catch in the entire Caprivi wetlands represented a cropping rate of 6kg per ha (van der Waal 1990), comparable to the 4.7kg per ha estimated for the Barotse floodplain (Welcomme 1974). The total catch of 1 279 tons for the study area represents a cropping rate of 20.8kg per ha. This seems high, but Welcomme (1974) estimated the productivity of African river/floodplain systems to be 40-60kg per ha at maximum flood. Using this relationship, the MSY of the entire Caprivi fishery would be 1800 - 2700 metric tons (Tvedten *et al*. 1994), making our estimate for the study area seem reasonable by comparison.

Fishers in both focus groups informed us that catches were good in years of high rainfall and high floods, and were poor when the reverse was true. Nanombe in the north of the study area, adjacent to the Zambezi River, had experienced reasonable flood levels a few times during the past five years, while Gomola in the south part of the floodplain had only recently received good floods. Both villages recall catch information that reflects this trend (Fig. 4.4.1)

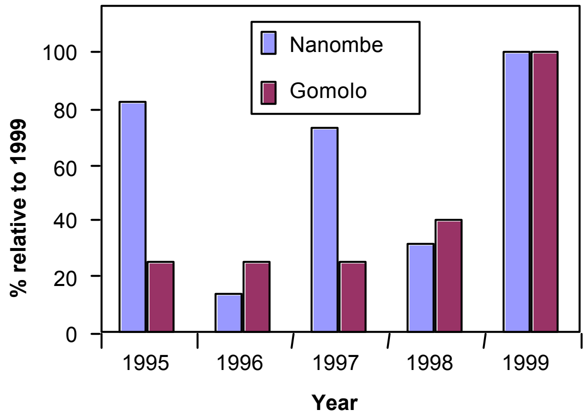


Figure 4.4.1. Focus group perceptions of variability in catches over the past five years

Despite cropping rates falling within Welcomme's (1994) productivity range, the sustainability of current levels of fishing is in question. Catch per unit effort (CPUE) for commercial gill nets declined in the Caprivi during the 1970s, particularly in the study area (van der Waal 1990, Table 4.4.7).

Table 4.4.7. Catch per unit effort in the study area (van der Waal 1990).

	1975	1976	1980
Fish per net set per night	5.9	4.1	2.6
Fish per fisher per night	28,7	23.9	15.5

The perception of villagers in the study area is that fish catches are on the decline, with better fish availability being experienced by fishermen in the 1960s and 70s than at present (Fig. 4.4.2). This is possibly due to increasing numbers of people entering the fishery leading to a lower CPUE, but may indicate a decrease in the size of the fish stock due to the increasing use of modern and illegal methods.

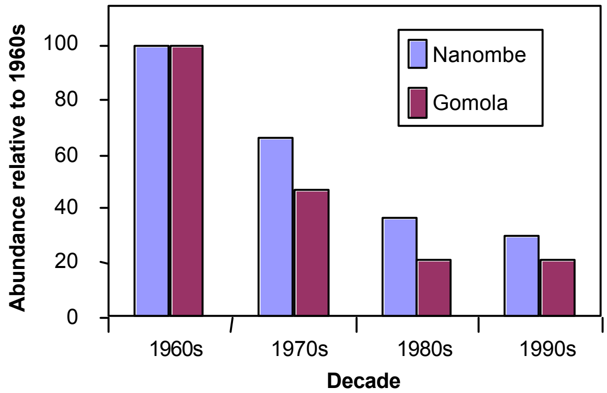


Figure 4.4.2. Focus group perceptions of changes in fish availability over the past four decades

Villagers expressed concerns that fish are declining in abundance because people are using small-mesh seine nets (drag nets). The normal mesh size of drag nets is the same as that for gill nets (30-50 mm), but smaller nets are increasingly being used. Villagers are aware that their dragnets are unselective and 'catch everything', but use them nonetheless (focus groups).

4.4.4 Wild animals

The numbers of large mammals in Caprivi are low when compared to Botswana (Rodwell *et al.* 1995, Timberlake 1997) and most large mammals are confined to the Reserves in the region (Mendelsohn & Roberts 1997). There is, however, movement of many species across the Botswana-Namibia boundary, especially at Chobe (Timberlake 1997). The Kabe constituency has almost no resident populations of large mammals, most of which were decimated during the South African occupation and have not had a chance to recover (Mendelsohn & Roberts 1997, Timberlake 1997, focus groups). There is some utilisation of waterbirds (ducks, geese, reed cormorants and darters) and their eggs on the river banks and floodplains in the study area.

A total of 22% of household survey respondents stated that they hunted wild animals, with all hunting being undertaken by men. The vast majority of these catch spring hares and rats and harvest waterbirds as a by-catch of gill netting. Occasionally, a hippo is shot, either legally or illegally, and the meat is divided among several households. Lechwe and sitatunga are taken whenever they can be found, either in snares of with dogs and guns. More than 50% of households regard their intake of bushmeat to be insufficient. User households catch an average of 167kg of wild animals per year, spending an average 21.5 hours per year hunting. Meat was priced at the cheapest alternative source (bulk beef in Katima Mulilo, N$8 per kg, Kirsten *et al.* 1999). All animals harvested are for domestic consumption. The values associated with this harvest are summarised in Table 4.4.8.

Table 4.4.8. Annual values associated with the hunting of wild animals and birds on the Chobe-Caprivi floodplain, based on household surveys and focus group data

	Namibian $		US $	
	Financial	Economic	Financial	Economic
Average per user household:				
Gross value (= home value)	1,335	1,335	223	223
Net value	1,299	1,277	216	213
Gross returns to labour (per day)	499		83	
For whole wetland area:				
Gross value	1,353,392	1,353,392	225,565	225,565
Net value	1,316,309	1,294,339	219,385	215,723

The net financial value per user household of N$1300 per year is probably an over-estimate of the true value since the household survey captured several households which claimed to have hunted hippos, substantially boosting the average number of kilograms harvested per year. However, the illegal catch, which would increase the average catch, is most likely poorly reported, making it difficult to obtain a true estimate.

The Chobe National Park adjacent to the study area has high densities of wildlife, especially of elephant. An element of the use value of this biodiversity is captured by the economic valuation of ecotourism below. There is another element of use value – illegal trans-boundary poaching – which is not captured in this study. A substantial amount of poaching, particularly of small antelope, is reportedly conducted at night in the Chobe National Park (*kuta* senior headmen: pers. comm., focus groups). There are no official figures available for the volume of bush meat acquired in this way, and while villagers in focus groups would admit to poaching, no information on species and volumes was forthcoming.

4.4.4.1 Variability and sustainability

There have been large decreases in wildlife numbers since 1980 in Caprivi, particularly of mammals specifically associated with the wetlands such as sitatunga, lechwe, sable, reedbuck, bushbuck and waterbuck (Timberlake 1997, *kuta* senior headmen: pers. comm., Mendelsohn & Roberts 1997, focus groups). The lechwe, a species which used to occur in large numbers on the eastern floodplains and the Chobe swamps, has dropped from over 11 000 in number in the early 1980s to just a few hundred in 1995 (Mendelsohn & Roberts 1997). This reduction is attributed to an increase in human populations and associated exploitation and habitat reduction, and habitat changes due to a decrease in rainfall (Mendelsohn & Roberts 1997).

Household surveys indicate that there is no variability in hunting effort over the year. Villagers in focus group meetings said that there had been no variability in catch over the past five years, which had been constantly poor. Most attributed the decline in animal populations to the period of South African Defence Force occupation in the 1970s and 80s, when extensive hunting was carried out from helicopters and military vehicles for both pleasure and to feed troops (Fig. 4.4.3).

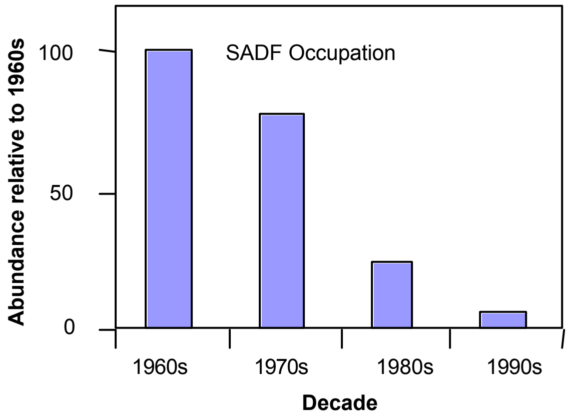


Figure 4.4.3. Chobe-Caprivi focus group perceptions of changes in wild animal availability over the past four decades (Gomola).

The Kabe traditional authority supports the proposed establishment of conservancies in the Kabe district (WWF-LIFE project, DEA Namibia, *kuta* senior headmen, pers. comm.). If the conservancy idea is to reintroduce wildlife, game guards must be employed to protect crops and stock, or compensation must be paid. The *kuta* believes that cultural identity would be enhanced if wild animals were brought back to Kabe for subsistence use, viewing and as a tourism attraction.

4.4.4.2 Wildlife conflicts

Wildlife often ranges across the border from the Chobe National Park, sometimes causing extensive damage to crops or taking livestock. Local communities come into conflict with several wild animal species in the Kabe district (Mendelsohn & Roberts 1997, tourist lodge representative: pers. comm., *kuta* senior headmen pers. comm.):

(a) Elephants from the Chobe National Park cross the river and feed on floodplain crop fields during the night, sometimes causing substantial damage. Problem ungulates and monkeys have been reported to a lesser degree.
(b) Hippos graze fields and trample crops. Sometimes fishermen are harassed on the bank or on the water. No deaths were reported. Hippos are sometimes shot, especially on the main channel of the Zambezi, allegedly by Zambian fishermen.
(c) Crocodiles injure or kill several people on the floodplain every year. They also take livestock and destroy fishing nets, especially gill nets left overnight. There are no active management practices to prevent this, but a crocodile management plan is being produced for the Lower Shire which may serve as a model.
(d) Flocks of granivorous songbirds descend upon crops while they are ripening or drying. Effort is expended by communities to keep them away, mainly through mechanical means and by children who chase birds.
(e) Lions and hyenas from Botswana occasionally take livestock

The Bukalo *kuta* feels that Botswana should pay some form of compensation for this damage. Currently none is paid, a source of some conflict. While total earnings from wildlife far outweigh wildlife damage costs in the entire region, the issue of who bears the costs is important. Loss of N$245 worth of crops to elephants, or an N$800 cow, is devastating to a rural household that is unlikely to be earning an “average” income from wildlife enterprises (Ashley & LaFranchi 1997).

4.4.5 Wild plants

The natural vegetation of the floodplains in eastern Caprivi provides many of the subsistence needs to rural households, along with opportunities for sales, barter and enterprise development (Mendelsohn & Roberts 1997, Ashley & LaFranchi 1997). Plant products include wood and timber products, leaves, fruits, nuts, barks, roots, tubers, reeds and grasses (Ashley & LaFranchi 1997). The degree to which these resources are used depends on their availability and the demands put on them.

Most homes are constructed with wood, reeds and thatching grass, and 96% of all households use firewood for cooking Mendelsohn & Roberts 1997). On the floodplains, construction poles and fuelwood are brought in from the upland woodlands by sled, usually by the men (*kuta* senior headmen: pers. comm.). Kitchen utensils and agricultural tools are often made from wood, while baskets and mats are woven from reeds and grass (Ashley & LaFranchi 1997). Some handicraft products (mainly tools) are made for the local markets. Not much is known about harvesting of wild foods on the floodplains, but a forestry assessment conducted by UNEP in 1995 identified 17 wild fruits and 12 wild vegetables consumed by floodplain households (Ashley & LaFranchi 1997).

4.4.5.1 Reeds and papyrus

Reeds (primarily *Phragmites* spp.) and papyrus (*Cyperus papyrus*) are used extensively for subsistence activities in rural eastern Caprivi (Mendelsohn & Roberts 1997). Reeds and papyrus are gathered from the low-lying wetland areas, particularly from the banks of the main river channels and the multitude of floodplain channels that criss-cross the floodplain (focus groups). They are harvested by hand using machetes and sickles, gathered into bundles and transported in sleds or on heads back to households, or to the market for sale. Each bundle is of approximately the same size, typically 35-40 cm in diameter, but differs in the quality and number of stems it contains.

Villagers in focus groups stated that harvesting of reeds and papyrus is done at the beginning of the dry season when the floodwaters recede, and before the main burning season (Fig. 4.4.4).

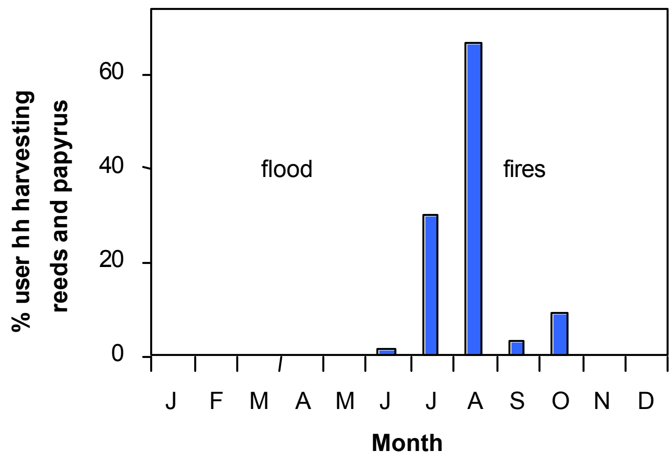


Figure 4.4.4. Proportion of user households in Chobe-Caprivi harvesting reeds and papyrus during different months of the year (from household surveys)

The value of reeds

Reeds are used for house construction, courtyard fences, fish baskets, fish wall traps, fish spears, fishing rods and handicrafts. In the study area, almost every household structure has a 'courtyard' constructed from reeds which serves as a cooking and eating place for household meals, a meeting place, a workplace for women, and an area of safety for young children (pers. obs.). The construction of courtyards is a cultural phenomenon and well-maintained courtyards appear to reflect household status and pride. Consequently most courtyards are maintained in a fairly new condition (*kuta* senior headmen: pers. comm.). Most courtyard fences, which require 3-6 bundles/m, are replaced every six months to three years (village meetings). Furthermore, some villages or households groupings in the region are entirely fenced in with a reed fence of almost identical structure to that of the courtyards. Reeds are also used extensively within the base matrix of permanent and temporary structures. The predominant use of reeds, which are inferior to wood, for construction, can be ascribed to the complete lack of suitable trees left on the floodplain (Mendelsohn & Roberts, 1997). Reeds are also used in the construction of many fish traps, both in the solid reed 'wall' that is laid across the smaller channels to block fish movements, and in the construction of large fish "baskets" that act as traps. These are usually replaced annually (village meetings).

A total of 90% of households reported harvesting reeds, spending an average of 30.2 hours a year to collect 24 bundles. About 70% of the harvesting is done by men and the remainder by women. 46% of user households sell most of their harvest at an average price of N$10 per bundle (focus groups). A total of 99 500 bundles of reeds are estimated to be harvested annually from the study area. The value of this activity is summarised in Table 4.4.9.

Table 4.4.9. Annual values associated with reed (*Phragmites*) harvesting in the Chobe-Caprivi wetlands, based on household surveys and focus group data

	Namibian $		US $	
	Financial	Economic	Financial	Economic
Average per user household:				
Gross value	240	254	40.00	42.40
Net value	237	223	39.47	37.25
Gross cash income	82		13.65	
Gross home value	158		26.35	
Gross returns to labour (per day)	64		10.60	
For whole wetland area:				
Gross value	995,195	1,054,907	165,865.85	175,817.80
Net value	982,082	926,739	163,680.27	154,456.57
Gross cash income	339,527		56,587.90	
Gross home value	655,668		109,277.95	

These values remain a conservative estimate of use value for several reasons. The many temporary reed-based structures and traps that herdsmen and fishermen set up are most likely excluded from this analysis as cutting is done on an *ad hoc* basis by junior members of the household and is unlikely to be recalled in the survey. The volume of reeds drawn from the study area and used in subsistence structures in Katima Mulilo (4202 households, Ashley & LaFranchi, 1997) and the adjacent higher lying areas to the west of the study area where numerous reed courtyards were in evidence is unknown. Furthermore, no data exists on the volumes of reed cut and sold commercially by operators in Katima. There is also a premium value in the provision of subsistence materials where there is a lack of alternatives.

The value of papyrus

Papyrus is primarily used in the production of a multitude of mats that are used for sleeping, sitting and drying crops on. It is also used as a framework material upon which to lay thatch in roof construction (village meetings). A total of 90% of households reported harvesting papyrus, spending an average of 11.2 hours a year to collect 17 bundles. About 80% of the harvesting is done by men and the remainder by women. 41% of user households sell about half of their harvest at an average price of N$15 per bundle (range N$2.50-20, focus groups). A total of 70 300 bundles of papyrus are estimated to be harvested annually from the study area. The value of this activity is summarised in Table 4.4.10.

Table 4.4.10. Annual values associated with papyrus harvesting in the Chobe-Caprivi wetlands, based on household surveys and focus group data

	Namibian $		US $	
	Financial	Economic	Financial	Economic
Average per user household:				
Gross value	254	270	42.38	44.92
Net value	251	256	41.86	42.69
Gross cash income	44		7.34	
Gross home value	210		35.04	
Gross returns to labour (per day)	181		30.24	
For whole wetland area:				
Gross value	1,054,285	1,117,542	175,714	186,256.98
Net value	1,041,468	1,062,018	173,578	177,002.93
Gross cash income	182,593		30,432	
Gross home value	871,691		145,282	

Value added

About 77% of households in the study area are involved in the production of papyrus mats, making an average of 5.7 mats per household per year. Most (93%) producer households sell almost all their mats at an average price of N$20 per mat. The value added by mats to papyrus use in the study area is given in Table 4.4.11.

Table 4.4.11. Annual values associated with making papyrus mats, based on household survey data

	Namibian $		US $	
	Financial	Economic	Financial	Economic
Average per producer household:				
Gross value	115	122	19	20
Net value	104	79	17	13
Gross cash income	106		18	
Gross home value	9		1	
Gross returns to labour (per day)	27		4	
For whole wetland:				
Gross value	407,274	431,711	67,879	71,952
Net value	367,718	279,899	61,286	46,650
Gross cash income	376,126		62,688	
Gross home value	31,149		5,191	

4.4.5.2 Grass

Several species of grasses are used for thatching, weaving and tying (e.g. *Tristachia superba* and *Andropogon huillensis*.). Thatching grass species occur both in the dry uplands and on the floodplain, although they are typically of different species. About 78% of homes in the whole Caprivi are thatched with grass (Mendelsohn & Roberts, 1997). Thatching a house takes between 200 and 2000 bundles of grass, and roofs are replaced every 5 - 10 years, although they can last up to 40 years if thatched well.

Grass harvesting occurs at the beginning of the dry season when the floodwaters recede (focus groups, household surveys; Fig. 4.4.5).

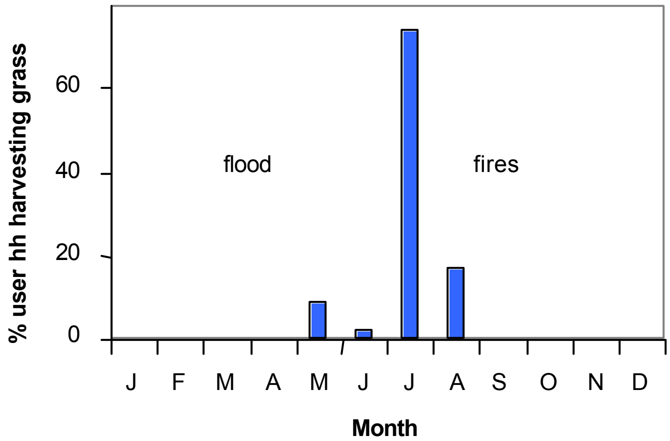


Figure 4.4.5. Proportion of user households in Chobe-Caprivi harvesting grass during different months of the year (from household surveys)

The value of grass

The household survey indicates that almost all households in the study area gather their thatching requirements in the immediate vicinity of their dwellings, and that thatch was abundant. A total of 77% of households reported harvesting grass, spending an average of 13 hours a year to collect 44 bundles. Thatching grass is collected in bundles of about 40-50cm in diameter, usually by men (78%) which is contrary to Ashley and LaFranchi (1997) who found that collection is generally by women. All bundles reported were standardised to 40cm. 61% of user households sell the majority of their harvest, at an average price of N$5 per large bundle (range N$0.7-5, focus groups). A total of 155 700 bundles of grass are estimated to be harvested annually from the study area. The value of this activity is summarised in Table 4.4.12.

Table 4.4.12. Annual values associated with grass harvesting on the Chobe-Caprivi floodplain, based on household surveys and focus group data

	Namibian $		US $	
	Financial	Economic	Financial	Economic
Average per user household:				
Gross value	220	233	36.58	38.78
Net value	218	219	36.34	36.55
Gross cash income	125		20.79	
Gross home value	95		15.79	
Gross returns to labour (per day)	135		22.51	
For whole wetland area:				
Gross value	778,717	825,440	129,786	137,573
Net value	773,612	777,962	128,935	129,660
Gross cash income	442,556		73,759	
Gross home value	336,161		56,026	

In comparison to these subsistence values, a rural commercial thatch harvesting enterprise in eastern Caprivi near Kongola employs several dozen rural households full time during the harvesting season in cutting and bundling thatching grass and selling to a commercial buyer at N$0.55 per bundle (DEA Namibia). This value per bundle is probably considerably lower than the local market price since the contract between rural gatherers and the private buyer was for a bulk order of 1 million bundles of thatch in one year (Ashley & LaFranchi, 1997). Bundle size is also most likely smaller.

These values must be considered minimum estimates for several reasons. Many permanent structures are partially re-thatched after storm damage, fire and other accidents on an *ad hoc* basis which respondents were unlikely to consider during interviews. Hundreds of large permanent communal structures are thatched collectively, requiring as many as 2000 bundles each. Collection of this thatch may not be included in household data. The value of other thatching grass products, such as woven mats and baskets, is not accounted for due to lack of empirical data.

4.4.5.3 Palm leaves

No information was obtained for palm utilisation from the focus groups, and the uses of palm fronds within the study area are thus unknown. In the household survey, 62% of respondents claimed to harvest an average of 13.6 bundles of palm fronds per year, but provided little other information such as input costs, selling price and uses of the product. It is most likely that palm fronds are woven into products such as drying mats, baskets and hats.

Harvesting occurs at the beginning of the dry season, after the floodwaters have subsided (Fig. 4.4.6).

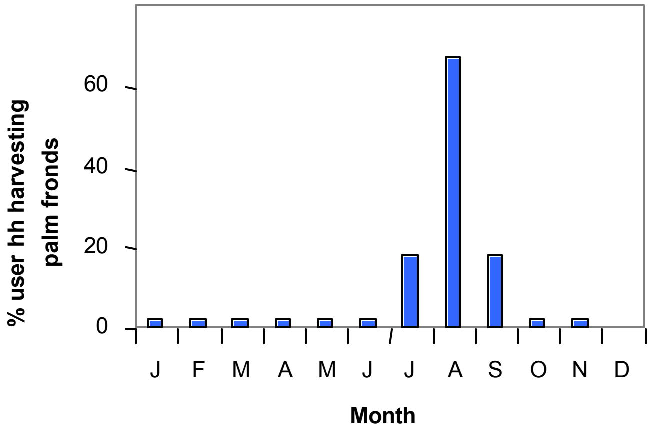


Figure 4.4.6. Proportion of user households in Chobe-Caprivi harvesting palm fronds during different months of the year (from household surveys)

A price per bundle of N$2.50 was assumed, based on an equivalent value found for the Delta study area, although this is probably an underestimate given the generally higher prices of other resources in the Chobe-Caprivi study area. Households spend an average of 22.6 hours per year harvesting, which is done primarily by women (84%). Inputs to production were assumed similar to reed harvesting. Half of all user households sell their total harvest. The annual values associated with palm fronds are given in Table 4.4.13.

Table 4.4.13. Annual values associated with the harvesting of palm fronds on the Chobe-Caprivi floodplain, based on household surveys and focus group data

	Namibian $		US $	
	Financial	Economic	Financial	Economic
Average per user household:				
Gross value	34	34	5.67	5.67
Net value	31	11	5.23	1.76
Gross cash income	16		2.72	
Gross home value	18		2.95	
Gross returns to labour (per day)	12		2.01	
For whole wetland area:				
Gross value	97,124	97,124	16,187	16,187
Net value	89,555	30,242	14,926	5,040
Gross cash income	46,541		7,757	
Gross home value	50,583		8,430	

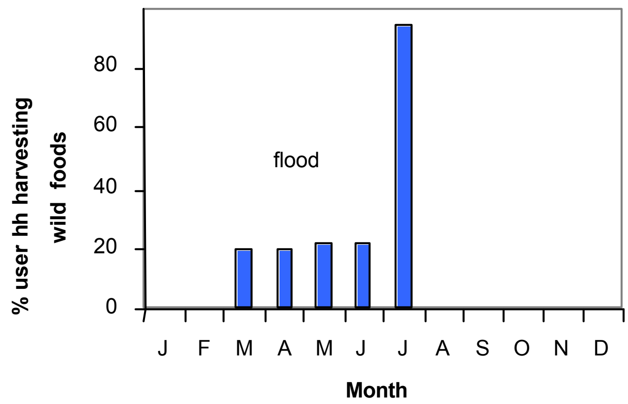
These values are most likely an underestimate of use value as they use a very conservative assumed sales price and exclude likely value added by palm products.

4.4.5.4 Wild Foods

Numerous wild plants in the study area are harvested for a wide variety of purposes. *Ino, Mashela, Makwangala* and *Makwakwa* are water lily bulbs that act as bulk carbohydrate substitutes during poor crop years, or for the months between harvests when grain supplies are running low. They are commonly found in marshy areas and pools on the floodplain and thrive in shallow water as floods recede. *Injilikilusa* is a bulb from low grass-like lawns which grow on the floodplains in shallow water, and are plentiful throughout the study area. The pinky-red leaves of *Insefwe* (water plant) and the flower of *Isoto* (water lily) are used as relishes in cooking. Other plants are used exclusively for medicinal purposes, e.g. the leaves of *Muhoto, Mutukutu* and *Molulwe* bushes close to the rivers are chewed to relieve coughs and stomach aches,

According to villagers, the harvesting of wild foods occurs while the floodwaters inundate the floodplain or while they are receding and shallow pools are forming (Fig. 4.4.7). Most of these plants thrive under such conditions, and are also easily accessible to be harvested by hand.

Figure 4.4.7. Proportion of user households in Chobe-Caprivi harvesting wild food plants during different months of the year



(from household surveys)

A total of 68% of households reported harvesting wild foods, spending an average of 54 hours a year to collect 47kg. Harvesting is by women (85%), often while on their way to harvest other resources. The value of this activity is summarised in Table 4.4.14. These values may be underestimated due to the high amount of time costs apportioned to this activity.

It must be noted that the model does not capture the values attached to the food security function of wild foods. The relatively low net financial value of N$94 per user household is a reflection of the relative abundance of this resource on the floodplain. Despite this low value, this resource is absolutely critical for the survival of households in the study area in poor crop years (focus groups).

Table 4.4.14. Annual values associated with the harvesting of wild food plants on the Chobe-Caprivi floodplain, based on household surveys and focus group data

	Namibian $ Financial	Economic	US $ Financial	Economic
Average per user household:				
Gross value	94	94	15.73	15.73
Net value	94	45	15.71	7.46
Gross cash income	58		9.64	
Gross home value	37		6.10	
Gross returns to labour (per day)	14		2.34	
For whole wetland area:				
Gross value	295,757	295,757	49,293	49,293
Net value	295,366	140,216	49,228	23,369
Gross cash income	181,176		30,196	
Gross home value	114,581		19,097	

4.4.5.5 Sustainability of plant resource use

Villagers did not see the harvesting of reeds, papyrus or grass as detrimental to the resource base. They expressed the belief that while it was necessary to travel some distances to get to the resources; plenty were available, even if reduced in places by harvesting, and that they regenerated fully each year. Nevertheless, they indicated that increased incidence of fires due to the clearing of fields for crops, improving pasturage and the clearing of areas for floodplain fishing has lead to a decline on both the availability window for harvesting and a decline in the long-term harvest volumes (Fig. 4.4.8).

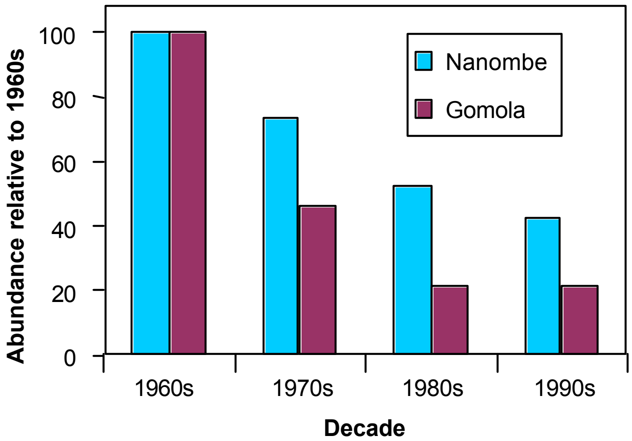


Figure 4.4.8. Chobe-Caprivi focus group perceptions of changes in reed, papyrus and grass availability over the past four decades

According to villagers, yields of food plants have fallen steadily over the last four decades, giving cause for some concern as to the sustainability of this harvesting activity (Fig. 4.4.9). This trend may, however, simply reflect the increase in population and the associate relative reduction in harvest associated with constant effort.

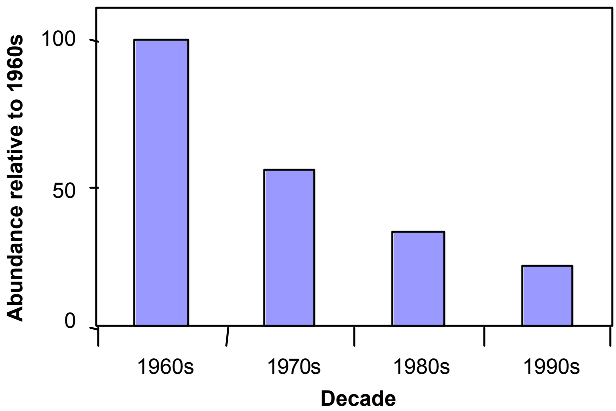


Figure 4.4.9. Chobe-Caprivi focus group perceptions of changes in wild food availability over the past four decades (Nanombe).

4.4.6 Ecotourism

Caprivi is a popular tourism destination for visitors, especially as it lies adjacent, and provides links to, popular attractions in Botswana and Zimbabwe (Mendelsohn & Roberts 1997). Tourism in Caprivi is currently growing faster than anywhere else in Namibia (about 20% per annum in Caprivi) capturing about 9% of all visitors to Namibia in 1996 (Ashley & LaFranchi 1997, Mendelsohn & Roberts 1997). Tourists to Caprivi are estimated to contribute about N$ 30 million annually to Namibia's national economy (Barnes, 1997 cited in Mendelsohn & Roberts 1997). The primary attractions in and around the study area include:

- the lodges along the Zambezi main channel near Katima Mulilo, which offer fishing, bird watching, cultural activities, and a transit point to western Zambia and Botswana,
- the lodges in the far eastern tip of Kabe and on Impalila Island, which offer game viewing, fishing, bird watching, and a transit point to Botswana and Zimbabwe.

About 90% of wildlife-viewing tourism in Botswana takes place in the broader Okavango-Chobe region (Barnes 1996). The Chobe strip in Botswana is also world famous for its river-based game viewing, especially of the Chobe elephants.

Lodges in and around the study area generate a substantial market value from "selling" wetland goods and services, amongst others, to tourists. Part of the reason that tourists travel to the area is to view and use the large diversity and numbers of mammals, fish and birds that are supported by the wetlands (Mendelsohn & Roberts 1997), as well as to appreciate the aesthetic beauty of floodplain and wetland ecosystems, and experience the relative uniqueness of boat-based game viewing along the Chobe river (Lodge representatives: pers. comm.). The regional 'market value' of tourism captured by tourist lodges in the Chobe-Caprivi system was calculated in this study and a proportion of this value was attributed to the wetlands.

The tow floodplain and two Impalila Island tourist lodges in the Kabe constituency and three of the five tourist lodges in the Kasane district on the Botswana side of the Chobe river were surveyed during the reconnaissance field trip. Data were gathered through interviews with lodge owners and managers. These data included:

- Number of beds,
- Occupancy rates,
- Tariffs,
- Estimates of running expenses and set-up costs,
- Employment figures and wage rates, and
- Information on activities offered

An existing model, developed by the DEA Namibia to estimate financial and economic returns to tourist lodge development in Namibia, was adapted to the Chobe-Caprivi system using the data gathered and Botswana shadow pricing and economic adjustment parameters where applicable. Two models were developed to reflect the two different lodge types operating at different scales (Table 4.4.15). This model assumes that tourists spend an average of four days per stay, and occupancy rates given are estimated at 10% lower than rates obtained during interviews due to a tendency to overestimate occupancy (J. Barnes: pers comm.).

Table 4.4.15. Input parameters for the small and large tourist lodge models for the Chobe-Caprivi region

Lodge type	Number of beds	Average length of stay (days)	Occupancy rate	Daily tariff (N$)
Small	18	4	45%	750*
Large	120	4	50%	700**

* Average of tariffs for Impalila Island Lodge, Impalila Fishing Camp, Kalizo Fishing Camp, King's Den Lodge and Chobe Chilwera Lodge
** Average of tariffs for Mowana Lodge, Chobe Safari Lodge and Chobe Game Lodge

The adjusted total net economic value for tourist lodges was estimated at US$785 637 per annum (Table 4.4.16).

Table 4.4.16. Annual financial and economic values of tourist lodges in the Kabe constituency and the Kasane district along the Chobe river, based on 1997 prices.

	FINANCIAL Net benefit		ECONOMIC Net benefit	
	N$ (1997)	US$*	N$(1997)	US$
Value per small lodge	366 970	74 892	888 444	181 315
Value per large lodge	1 400 226	285 760	4 639 147	946 765
Total value*	6 402 498	1 306 632	19 248 105	3 928 185
Adjusted Total Value**	1 280 500	261 327	3 849 621	785 637

* based on six small lodges and three large lodges
**assumes only 20% total lodge value attributable to the wetland areas

This study assumes that only 20% of the value generated by tourist lodges in this region can be directly apportioned to wetland areas. The literature on economic valuation contains many arguments as to whether, and how, one can apportion value among individual attributes of an aggregated environment (see V. Kerry Smith 1996 for a discussion of various issues regarding aggregate values estimated through non-market valuation techniques). Clearly, tourists visit the region for a multitude of reasons. Some are not directly associated with the wetlands at all, but are on business or in transit to Namibia, Zambia and Zimbabwe. Others are indirectly associated with the wetlands, involved in conferences, game viewing, and relaxation while some visitors come specifically for the goods and services provided by the wetlands - fishing, birding, and canoeing. It is reasonable then to assume that most of the value generated by some tourists is due to the presence of the wetland areas, while for other tourists, only a small portion of the reason for their visit is due to the wetlands. Since no empirical data exits, this study simply assumes the proportion is 20%

The values generated in this study do not represent the full value of ecotourism to the region. Financial incomes and economic benefits accrue to many other tourist enterprises such as hotels, camp sites, boat hire, car hire, gift shops, guest houses in Kasane and Katima Mulilo and trophy hunting in Botswana. In addition, there are a host of subsidiary tourist industries such as food and fuel suppliers, construction firms and local craftsmen that are not considered in this study. There are also a number of economic impacts that add social, though not necessarily financial, value to the region. These include the direct spending on capital and running costs by tourist operators in the regional economy as well as money cycled into the regional economy through labour wages being spent locally. Tourist industries provide a wide range of cash-earning opportunities for rural Caprivians and Botswanans, boosting household income to provide a coping mechanism during poor agricultural years (Ashley & LaFranchi 1997) and a means of improving status and wealth through cattle acquisition.

The attraction of the Okavango-Chobe complex to international tourism in Botswana is substantial (Barnes 1996) and hence, a large portion of national tourism value and impacts at the national level is attributable to some degree to wetland ecosystems in Botswana.

It should be mentioned that ecotourism also has a number of costs that were not considered in this study and that need to be quantified. Rural households are often excluded from areas of traditional access when parks are proclaimed and communities sometimes experience intrusion and breakdown of cultural identity (Ashley & LaFranchi 1997). As mentioned above, conflicts with wildlife occur when densities are maintained high enough to satisfy tourist demand for viewing. Changes in biodiversity and environmental quality can occur at high stocking densities (Timberlake (1997) likens the elephant impact along the Chobe to an 'ecological disaster'). Finally, tourist activities and supportive infrastructure potentially damage environments and utilise scarce resources (e.g. water) (Ashley & LaFranchi 1997).

4.4.7 Overall use value and local perceptions

4.4.7.1 Annual use value

According to this study, households perceive fish to be by far their most important source of income (including non-cash income). Cattle and livestock were perceived to generate similar value. Wetland resources were of significant value, and were perceived to be more important than upland resources. Cash income from jobs is small in comparison with other values (Fig. 4.4.10).

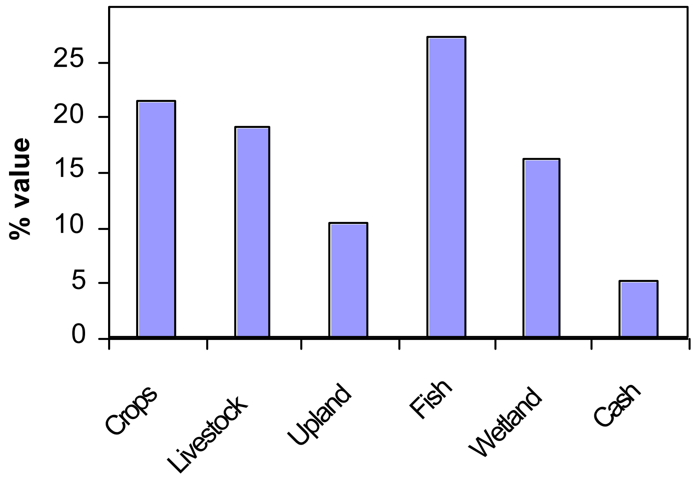


Figure 4.4.10. Mean perceptions of Chobe-Caprivi households as to relative income (including non-cash income) from different resources (household survey data).

According to this study, cattle are the most important source of value and cash income in the wetland, with fish generating the second largest values (Table 4.4.17). Crops are an important source of subsistence value to households, but generate relatively little in the way of cash income. Crops have a highly negative economic value, however. Other wetland resources, particularly reeds, papyrus and grass, all generate substantial income to households, accounting for 16% of the gross economic value of the wetland. In all the wetland is estimated to be worth approximately US$5.3 million annually to the economy in terms of its gross use value, with a net economic value of US$4.7 million. These values would be considerably higher if cropping activities were not taken into account.

The relative values obtained in this study agreed well with the perceptions of relative value given in the household survey (Fig. 4.4.11), except that cattle were found to be more valuable than perceived by the local people.

Table 4.4.17. Summary of current consumptive use values of the eastern Caprivi-Chobe wetlands

CAPRIVI-CHOBE	Cattle	Crops	Fish	Ani-mals	Reeds & papyrus	Palms	Grass	Wild foods	TOTAL
Average wetland hh (US$/y)									
Gross financial value	422.0	219.3	323.8	48.96	88.87	3.51	28.17	10.70	1,145
Net financial value	422.0	212.9	224.5	47.62	86.50	3.24	27.98	10.68	1,035
Gross cash income	54.7	11.1	23.3	-	32.49	1.68	16.01	6.55	146
Gross home value	367.3	208.2	300.4	48.96	56.38	1.83	12.16	4.14	999
Total wetland (US$ '000s/y)									
Gross economic value	2,061	753	1,581	226	434	16	138	49	5,277
Net economic value	1,831	-3,938	694	219	378	5	130	23	4,770
Gross financial value	1,944	1,011	1,492	49	409	16	130	49	5,277
Net financial value	1,944	981	1,034	23	399	15	129	49	4,770
Gross cash income	252	51	108	30	150	8	74	30	672
Gross home value	1,692	959	1,384	19	260	8	56	19	4,604

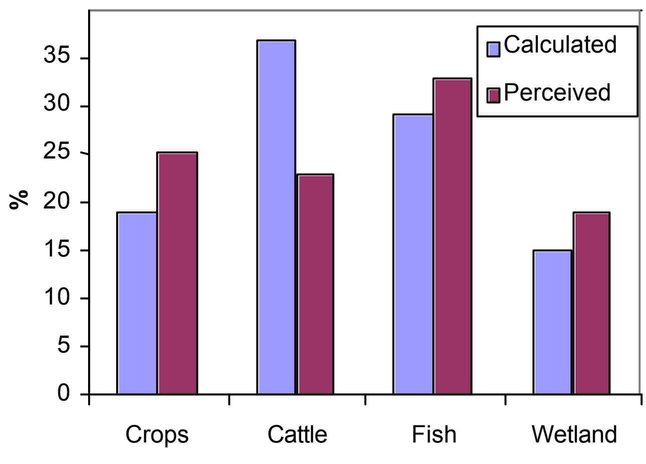


Figure 4.4.11. Relative measured value of crops, cattle, fish and wetland resources obtained in this study for the Chobe-Caprivi, vs. their relative perceived value.

4.5 THE LOWER SHIRE WETLANDS

Information on the biophysical resources of the Lower Shire wetland study area is fairly sparse. Biological collections have been poorly documented, few studies have been carried out, and resource inventories precipitated by development plans are mostly pre-1980 (Timberlake 1997; Chimphamba & Msiska 1997). Consequently, this section relies heavily on information from the household surveys, focus groups and village meetings, with very few comparisons with the literature being made.

4.5.1 Livestock

Cattle graze in the both the uplands and wetlands, spending some months along the floodplain margins during the receding flood (focus groups). Cattle are watered daily on the wetland and along the main channel. "Dambos" are used for grazing during dry season and drought years (village interviews). Grazing is best on the wetland in the dry season during October-November, since there are crop residues. All cattle have to move to the upland during the planting season so that they do not damage the crops (village interviews), and the during the peak flood (household surveys). The seasonality of cattle movements are shown in Fig. 4.5.1.

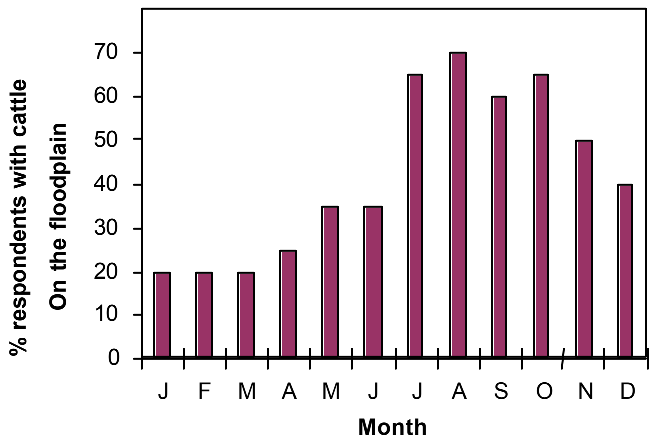


Figure 4.5.1. Seasonality in the grazing of cattle on the Lower Shire floodplain, showing the proportion of respondents with cattle on the floodplain in each month.

In this study, the household survey found that 18% of households in the study area own an average of 10 cattle and 21% of households additionally keep an average of 2 cattle for upland households. A greater proportion of wealthy households have cattle, and wealthier owner households have larger herd sizes (Fig. 4.5.2).

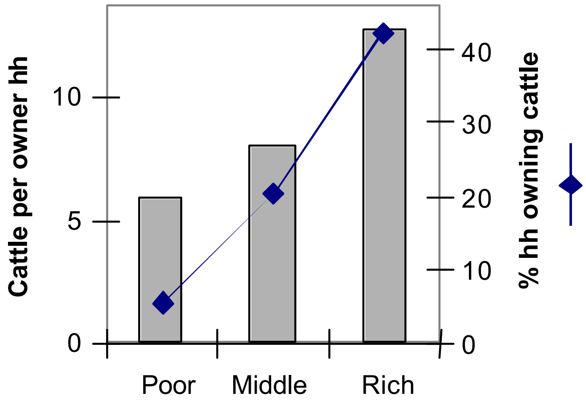


Figure 4.5.2. Percentage cattle owning households in the Lower Shire, and average herd size among poor, middle and rich status households (household survey data).

Based on the survey data, we estimate that a total of 104 450 cattle are grazed on the floodplain during the non-flood season. This estimate may seem high, but reflects a density of 43 cattle per km^2, which is lower than in the Chobe-Caprivi study area. While some households graze their cattle on the floodplain throughout the year, others may use it for no more than three months. On average, we estimated that the entire herd spends seven months a year on the floodplain in the study area.

Small stock animals are relatively important in the study area due to the low proportion of households that own cattle. The proportions of households owning small stock and the average number owned, as found in the household survey, are compared with figures for the Lower Shire valley for 1994 in Table 4.5.1 (CSR 1994).

Table 4.5.1. Percentage of households owning livestock by type and an estimate of the mean number owned per household in the study area and the Lower Shire valley (household surveys, CSR 1994).

	Household survey		CSR 1994	
Livestock type	% hhs owning livestock type	Mean no. per hh	% hhs owning livestock type	Mean no. per hh
Cattle	18	10	9	9
Sheep	2	11	1	30
Goats	47	5.2	24	7
Pigs	12	10	6	4
Chickens	79	15	43	5
Pigeons	4	20	3	8
Ducks	6	6.8	4	4

The household survey found a herd composition similar to that reported in the lierature for other wetland areas (e.g. Paskin & Hoffmann 1995). A total of 45% of all cows were reported to be milking cows, producing an average of 1.8 litres of milk per day. This yields an estimate of 301 litres of milk per cow (all cows) per year. This is similar to figures reported for both the Baroste wetlands and the Chobe-Caprivi wetlands.

On average, the annual sales and home consumption proportions of 4.8% and 1.5% respectively found in the household survey were similar to those reported in the literature for other sites. The average selling price for a head of cattle was estimated at a mean MK2 250 (range 1300 - 4500, focus groups and household surveys). Most (87%) households use hired herdboys, at an average wage of a little over MK10 per day. The value of grazing in the study area was taken to be the productivity of cattle during the seven months they spend on average within the floodplain area (household surveys, focus groups), including the value of milk and manure production. Results are summarised in Table 4.5.2.

Table 4.5.2. Annual values associated with cattle grazing on the Lower Shire floodplain, based on household survey and focus group data

	MK Financial	MK Economic	US $ Financial	US $ Economic
Average per cattle-owning household:				
Gross value	7,582.65	9,099.18	169.44	203.33
Net value	7,582.65	8,594.91	169.44	192.06
Gross cash income	514		11.48	
Gross home value	7069		157.96	
Gross returns to labour (per day)	14.04		0.31	
For whole wetland area:				
Gross value	79,202,012	95,042,415	1,769,877	2,123,853
Net value	79,202,012	89,775,202	1,769,877	2,006,150
Gross cash income	5,367,34		119,941	
Gross home value	73,834,667		1,649,937	
Gross returns to land (per ha)	752	903	16.81	20.17
Cash returns to land (per ha)	51		1.14	

4.5.2 Crops

Agriculture is the backbone of Malawi's economy, contributing the highest portion of the GDP (35%) and national export earnings (85%; Ngongola & Kapwepwe 1994, Chaweza 1998). The national agricultural sector is divided into two sub-sectors: smallholder and estate. The smallholder sub-section accounts for nearly 80% of total agricultural production and rural smallholder farmers that derive their livelihood from farming comprise about 85% of the total population of Malawi (Ngongola & Kapwepwe 1994). Maize is the staple grain crop of Malawi and accounts for more than 70% of the country's annual cultivated area on average (Ngongola & Kapwepwe 1994). The estate sub-sector has historically produced tea, sugar, tobacco and cotton and has been the major foreign exchange earner (Chaweza 1998).

Most of the Lower Shire valley is customary land under smallholder farming (Ngongola & Kapwepwe 1994). During a series of below-average rainfall years in the river and Lake catchments, Elephant Marsh becomes very dry, allowing almost total cultivation of the marsh area of 60 000 ha. Cropping patterns have historically varied tremendously from year to year depending on soil moisture content and the changing national and international demand for various agricultural products (Timberlake 1997). Major crops grown on the marshes of the Lower Shire include maize ('pure stand local' and a little hybrid/improved), sorghum, millet, beans, rice, cotton, cassava and Irish potatoes. Local maize is grown for purposes of local consumption, with only 2% of households selling local maize. Hybrid maize, cassava and Irish potatoes are mostly sold (CSR 1994, pers. obs, focus groups). Sweet potatoes are also important (F. Kalowekamo, pers, comm.).

Almost all (97%) respondents of the household survey are engaged in subsistence farming. The average area cultivated per household is 2.83 ha, with the slightly larger richer households having larger fields on average (4.1 ha) than middle (2.4 ha) and poor households (2.1 ha). In comparison, Ngongola & Kapwepwe (1994) found that 75% of Malawian smallholders cultivated less than 1.5 ha of land in 1987/88. The average planted area in the Nsanje district was 4.2 ha in 1993, but the majority of households plant under one hectare (CSR 1994). However, most farmers surveyed cultivate fields in both the study area and in the uplands, sometimes even beyond the boundaries of the study area. On average, 54% of farmland is on the wetlands, suggesting that some 82 250 ha, or 52% of the total wetland area, is planted under crops. Similar figures are reported for the Nsanje district where 43% of total land area is under smallholder cultivation, and 1.7% under commercial estates (CSR 1998). These figures support the Biodiversity Assessment team's contention that these wetlands are very heavily impacted.

Maize yields for Malawi averaged 1100 kg/ha in 1994, equivalent to the national average of the previous 10 years (Ngongola & Kapwepwe 1994). Average yields in the Shire valley appear to be lower than the national average (Table 4.5.3), possibly due to the greater prevalence of local maize varieties in the Shire area and the relatively unfavourable climate.

The actual crop yields obtained in the household survey were varied, but mostly average, with the maize yield of 723kg/ha comparing favourably with the 10-year average for the Shire valley reported in Table 4.5.3. The main crops grown in the study area, mean field size, total area, and their reported yields and prices are listed in Table 4.5.4.

Table 4.5.3. Maize production, yields and area cultivated for the Shire valley, 1984-1993 (source: Ngongola & Kapwepwe 1994)

Year (season)	Maize production (tons)	Maize yield (kg/ha)	Area cultivated (ha)
1984	20172	980	20500
1985	21240	1000	21240
1986	18169	624	29127
1987	26547	996	26647
1988	15923	659	24157
1989	23826	827	28823
1990	42521	813	52284
1991 (drought)	7939	213	37230
1992	44635	917	48675
1993	38862	639	60811
Average		767	

Table 4.5.4. The main crops grown in the Lower Shire study area, mean field size, total area, and their reported yields and prices

Crop	% farmers	Mean area per hh (ha)	Total area (ha)	% area	Yield (kg/ha)	Price/kg (1999 MK)
Maize	97	1.30	73 116	85	724	7.25
Rice	47	1.07	29 176	70	1084	5.89
Sugarcane	31	0.12	2 164	8	124	5.00
Sweet Potatoes	54	0.95	29 525	62	1081	5.95
Legumes	67	0.83	32 084	54	188	8.16
Millet/sorghum	4	0.32	745	21	772	4.79
Cassava	5	0.12	362	8	457	3.63
TOTAL			167 171			

The reported proportions of households growing different crops in Nsanje District are summarised in Table 4.5.5 for comparison.

Table 4.5.5. Estimated percent of households growing particular crops in the Nsanje district (CSR 1997).

Crop	% Households growing crop
Local maize	59.6
Hybrid maize	12.3
Rice	8.9
Cassava	0.6
Cotton	6.0
Groundnut	4.6
Irish potato	4.2

In Malawi, soil fertility losses from croplands are estimated as 0.3–0.17kg N/ha/year (Ngongola & Kapwepwe 1994). This can be converted to a cost of fertilisers required to offset this loss. While national losses were estimated be worth up to MK17/ha in terms of fertiliser costs, these losses were estimated to be somewhat lower in the Lower Shire valley (MK10.26/ha). Based on household surveys where only 5% of wetlands farming households reported using fertiliser or manure, a combined cost MK7/ha is used in the model as a value for fertiliser inputs.

Data on sales prices for crops were taken from household surveys and focus groups. About 30-50% of agricultural produce is sold on the village market, and the remainder is sold on the local markets (18.6%), in cities, and to buy-back commercial schemes (household surveys, CSR 1994). Household labour on crop production annually was approximately 1 995 hours (estimated from focus group crop/effort calendars). This equates to similar labour hours per hectare per year as the figures for the Barotse and Chobe-Caprivi wetlands. The value of agricultural production on the Lower Shire wetlands, estimated for the 54% of total cultivated area, and assuming crops are planted in the same proportions in uplands and wetlands, is summarised in Table 4.5.6.

Table 4.5.6. Annual values associated with the cultivation of the Lower Shire wetlands, based on household survey data

	MK		US $	
	Financial	Economic	Financial	Economic
Average per user household:				
Gross value	14,022	12,597	313.34	281.50
Net value	13,881	10,772	310.20	240.72
Gross cash income	2,106		47.06	
Gross home value	11,916		266.27	
Gross returns to labour (per day)	56.23		1.26	
For whole wetland area:				
Gross value	772,985,513	694,440,636	17,273,419	15,518,227
Net value	765,243,275	593,834,669	17,100,408	13,270,048
Gross cash income	116,101,082		2,594,438	
Gross home value	656,884,432		14,678,982	
Gross returns to land (per ha)	9,175	8,243	205.04	184.20
Net returns to land (per ha)	9,083	7,049	202.98	157.52
Cash returns to land (per ha)	1,378		30.80	

The area under maize in the Shire Valley has expanded markedly in the past decade, and by five years ago (1993), the production was almost 40 000 tons (CSR 1994). This represents a gross income of MK21.76 million (US$968 900) and a gross margin of approximately MK 14.1 million (US$626 700). This is lower that the 52 900 tons of maize found by this study for the production in the study area.

Although very little fertiliser is used in the area (CSR 1994, household surveys), there is stated concern that the use of soils in the study area is unsustainable, and that soil fertility is decreasing (village interviews, focus groups). Nevertheless, Lower Shire cattle owners do not seem to pen their cattle in strategic locations where the manure can be used as fertiliser (E. Hiscock, pers. comm.).

Commercial estates and irrigation schemes are prominent in the study area and represent additional value to wetland cropping. These include the ILLOVO Sugar estate, and irrigation schemes at Kasinthula, Nkhate and Muona. Irrigation schemes have been developed by the government in an attempt to raise agricultural yields, and hence food security and living standards in the valley. Data are only available at this stage for the sugar estate and Nkhate irrigation scheme, and these are described below.

Nkhate Irrigation Scheme

The Nkhate Irrigation Scheme covers 233 ha and involves 865 farmers, from 456 families, including 111 female-headed households. Each farmer has two 0.1 ha plots. The scheme started as a government scheme, but ownership is in the process of being handed over to the farmers. The main crops in the scheme are rice, maize and beans (Table 4.4.6). Crops are sold to private buyers, and prices are negotiated by a marketing committee. The scheme is in the process of forming a marketing co-operative. Only research-approved varieties are grown and yields in the scheme are high. Several crops, including rice and maize, have two growing seasons per year. Financial gross income from the scheme is over US$ 0.5 million (Table 4.5.7), amounting to US$2323 per ha per year.

Table 4.5.7. Yield statistics and financial values for irrigated and non-irrigated crops in the Nkhate irrigation scheme (source: Nkhate irrigation scheme, Malawi, 1998**).**

Crop	Yield Kg/ha		Price/kg (1997)		Gross income per ha (US$)		Total gross income (US$)	
	Irrigated	Non-Irrigated	MK	US$	Irrigated	Non-Irrigated	Irrigated	Non-Irrigated
Maize	3,000	1,500	1.55	0.068	206.67	103.33	20 666	10 333
Faya Rice	5,500	2,500	3.5	0.155	855.56	388.88	156 566	71 166
Vegetables	3,000	1,000	2	0.088	266.67	88.89	586	195
Cow Peas	1,000	1,500	2	0.088	88.89	133.33	4 444	6 666
Mixed Beans	1,000	600	3	0.133	133.33	80	600	360
Soya Beans	1,500	600	2.5	0.111	166.67	66.67	1 666	666
Sweet Potatoes	10,000	800	2	0.088	888.89	71.11	151 111	12 088
Pigeon Peas	1,500	1,000	2	0.088	133.33	88.89	6 666	4 444
							342 309	198 992
TOTAL								541 231

Inputs to the scheme are also high, however, and include pesticides, organicides and fertiliser. Fertiliser inputs are 175kg/ha, amounting to MK1365/ha or US$61/ha. Farmers have to apply for collateral at 35% interest in order to cover these expenses. The other major cost is the cost of irrigation itself and keeping the irrigation channels free of weeds. This is a gravity-fed scheme which uses 1.545

m^3 per second during the wet season (November - March) and 0.142 m^3 during the dry season. Farmers are not charged at present, but the water will have to be priced when the farmers take over ownership. Adjacent smallholder rice farmers take advantage of the wastewater from the scheme.

ILLOVO Sugar Estate

The Sugar Corporation of Malawi (ILLOVO) sugar estate adjacent to Elephant Marsh has 11 000 ha under irrigated sugar cane, of which about 1 000 ha is seed cane. Output of cane sugar in 1997, which was a bad year, was 111 000 tonnes, which is 10% of total cane weight cut. Expected yield in a good year is 127 000 tonnes. In the near future, ILLOVO aims to increase production to 145 000 tonnes/year. World sugar price in March 1998 was US$0.27/kg for raw sugar, implying an average gross turnover by ILLOVO of about US$32.13 million, which amounts to US$2 921 per ha (Note: world sugar price has subsequently dropped to US$0.19/kg in September 1999). ILLOVO use approximately 400 000 m^3 of water per day to irrigate the cane during the dry season. They are the third largest consumer of electricity in Malawi, using 28 552 000 Kwh of electricity a year, mainly for pumping water, at a cost of MK21 242 000. The estate employs 7 500 unskilled workers in the peak season (April-November) and 3 500 in the low season (December-March). Virtually all workers are from the surrounding area, as the estate has a policy of employing local people as unskilled workers. About 80% of this workforce are housed on the estate. ILLOVO has started an outgrowers scheme at the old government irrigation scheme of Kasuntuna, where smallholder farmers have formed a producers association and will sell all their cane to ILLOVO. Each farmer cultivates 1 ha of sugar cane out of a total area of 800 ha. They estimate that gross income per farmer from cane will be MK32 000-36 000/year, or US$1400-1600 (Mr. R.C. Apsey, ILLOVO, pers. comm.).

4.5.3 Fish

After Lake Malawi, the Lower Shire wetlands have the largest number (12) of exploitable fish species in Malawi. All the commercially-utilised species use the shallow floodplain for breeding and any reduction in floodplain area constitutes a commercial threat (Timberlake 1997). Fish and fisheries play a major role in the economy of the Lower Shire and provide dietary protein for many rural households, and for urban dwellers as far away as Blantyre (Ratcliffe 1972 in Chimphamba & Msiska 1997). The main fishing areas are the channels and lagoons in the three marshes, and well as those around Chikwawa which form the main breeding grounds of most fish species (Ratcliffe 1972 in Chimphamba & Msiska 1997, village interviews). Malawians exploit the Moçambican side of Ndinde Marsh, and further south, the Moçambicans also fish on the Malawian side (W. Waleru, Fisheries Officer, Nsanje, pers. comm.).

The Lower Shire fisheries have been well studied in the past, and comprehensive fish checklists are available (Timberlake 1997). However, the last studies were conducted in the 1970s, and the conditions in the wetland have changed substantially since then (village interviews). Furthermore, these studies were conducted during a period of "extraordinarily wet years of 1976 – 1983, when lake levels reached historic heights (in 1980)" (Timberlake 1997). Water levels in Lake Malawi are declining at present.

4.5.3.1 Species and fishing methods

Three species make up 90% of the Lower Shire catch: two catfish *Clarias gariepinus* and *C. ngamensis*, and one cichlid *Sarotherodon mossambicus*. *Eutropius depressirostris* and *Marcusenius marcroliepidotus* were also important (Willoughby & Tweddle 1978). Most households fish to some degree, using various types of conventional and traditional fishing gear such as gill nets, fish traps, hooks, cast nets, scoop/dip netting, seine netting, plunge baskets, fish spears and arrows (Ratcliffe 1972 in Chimphamba & Msiska 1997).

Gill nets are the most common conventional fishing gear among fishermen with 15% of fishing households reportedly using an average of 3 nets at any one time. The average price of a 50-yard gill net ranges between MK300 and MK450 depending on quality (household surveys, focus groups). Cast nets and drag nets are used by 3% and 1% of fishing households respectively. Dragnets are about 100-300m, and made of various materials, such as connected gill nets, at a cost of about MK5 000 (focus groups), but mosquito netting and shade netting is also widely used (personal observation). Dragnets are meticulously repaired and last for up to 10 years.

Many fishermen use traditional gear, employing a variety of traps, fences and funnels, spears and baskets. Wall traps constructed from reeds are used by 27% of fishing households. Only 1% of fishermen reported using dug-out canoes, costing approximately MK1 725 each and lasting seven years. This is most likely a large under-estimate (pers. obs.).

4.5.3.2 Seasonality, effort and catch

Fishing in the study area is seasonal, with up to 80% of fishing households actively fishing in the receding floodwaters (April to July), usually with traps and gill nets. During the low-water period (November to January), fishing is confined to the Shire River main channels and the permanent lagoons such as Lisuli (Fig. 4.5.3). During this period, some 40% of fishing households still fish at least occasionally (household surveys).

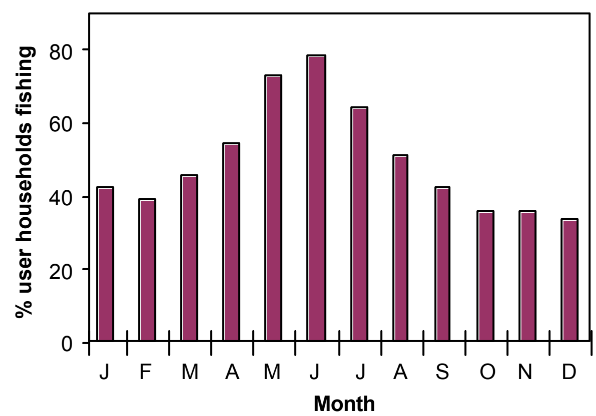


Figure 4.5.3. Proportion of Lower Shire user households fishing during different months of the year (from household surveys).

According to previous studies, the Lower Shire wetlands had a fish production of 6 874 tons per year, and a mean yield of 100 kg/ha (Timberlake 1997). Based on the area of the wetland, Welcomme (1975) estimated its annual fish production to be in the region of 9 000 tons. It was predicted that water weeds, pesticide runoff from sugar estates and over-fishing would probably have reduced this considerably by now (Timberlake 1997).

This study found that 53% of all households in the study area are engaged in subsistence fishing, averaging 2 200 fishing-hours per household per year. Fishing is primarily by men (92%), with women and children helping only during the peak fishing period. Mean reported household catch was 317kg per year for fishing households, with no significant difference in percentage households fishing or catch size between households of different wealth status. This yields a total catch of about 9 750 tons for the study area. This catch figure is high and although within theoretical bounds, contradicts the decline prediction in the previous paragraph. It is possible that households overstated their average annual catch, or that the household survey simply hit a higher than average number of fulltime fishermen.

A total of 40% of fishing households sell an average two thirds of their catch for cash income. Fish from Ndinde Marsh are smoked and later sold in Blantyre by the households that caught them. Some fish are sold locally to middlemen who transport them to the cities. Prices of fresh and dried fish fluctuate between MK10-20 per kg, depending on the species, season and market. A household subsistence fishery model was developed for the Lower Shire study area, based on the reported catch, price and input data. The results of the model, given in Table 4.5.8, indicate that subsistence fishing yields high values to wetland households.

Table 4.5.8. Annual values associated with the Lower Shire fishery, based on a model of a subsistence fishing household, using household survey data.

	MK Financial	 Economic	US $ Financial	 Economic
Average per user household:				
Gross value	4,761	5,713	106.39	127.67
Net value	2,509	1,468	56.07	32.80
Gross cash income	1,236		27.62	
Gross home value	3,525		78.77	
Gross returns to labour (per day)	17.40		0.39	
For whole wetland area:				
Gross value	146,425,500	175,710,600	3,272,078	3,926,494
Net value	77,172,893	45,146,510	1,724,534	1,008,861
Gross cash income	38,013,425		849,462	
Gross home value	108,412,075		2,422,616	

4.5.3.3 Variability and sustainability of the fishery

Fishermen from Lisuli, a permanent lagoon on the north end of Elephant Marsh, informed us that catches were highly dependent on floodwater levels. Poor floods resulted in a low annual catch. In 1997, a good flood maintained water levels high in the lagoon for many months, resulting in a good catch for the first time in several years (Fig. 4.5.4).

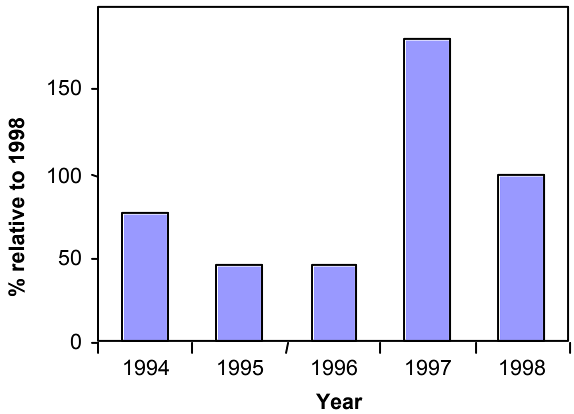


Figure 4.5.4. Lower Shire focus group perceptions of variability in catches at Lisuli over the past five years

There was considerable variation in the perception of the status of the fishery among three different focus groups. Fishers from Marka and from Lisuli claim that catches have declined over the past two decades and that big fish are increasingly difficult to find (Fig. 4.5.5). They claimed that Tilapia and *Njole* are disappearing from the lagoons due to destructive modern methods such as small-mesh gill nets and mosquito netting used as drag nets. Although fishers from Marka perceive a much steeper decline since the 1970s than those from Lisuli, both groups indicated that catches in the 1990s have been about half as good as catches in the 1980s. Indeed the official average catch recorded in the 1990s is 51% of the average catch recorded for the 1980s (see below). Villagers from Nsanje, however, maintain that fish catches are the same now as they have always been.

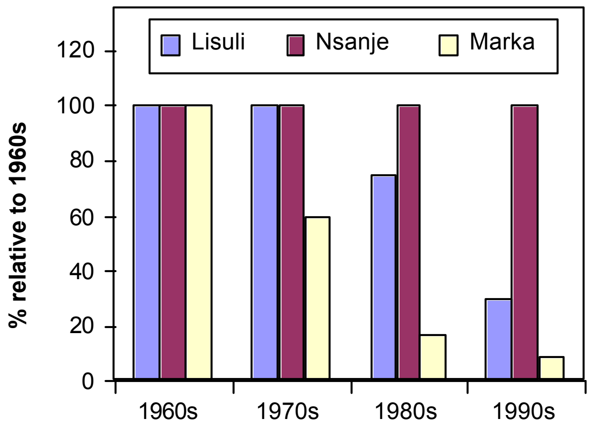


Figure 4.5.5. Lower Shire focus group perceptions of changes in fish availability over the past four decades, and relative change in the mean annual catch recorded in the 1990s and 1980s,

Official fisheries statistics provide evidence for fluctuating fish stocks in the wetland, with major declines in recent years (Table 4.5.9). These figures generally indicate a much lower annual catch than the 9 750 tons found by this study, or the 6000-9 000 tons found in the literature. It must be noted, however, that these are fisheries statistics for formal fishing as measured by monitored landed catches on landing beaches, and in a sense, are in fact representative of semi-commercial enterprises. What is important to note is the trend of declining catches.

Table 4.5.9. Shire Valley fisheries statistics. Fishermen are those that own equipment (M. Maloya, Makhanga fisheries, *in litt.*). Most of the data is recorded from Elephant marsh.

Year	Annual catch (metric tons)	Number of fishermen
1983	5245	2253
1984	6897	no data
1985	6597	2293
1986	8511	no data
1987	7077	no data
1988	8169	2038
1989	10946	1881
1990	6925	2504
1991	9309	1651
1992	2958	1662
1993	2873	1365
1994	1643	1159
1995	1905	no data
1996	1848	no data

From the above, it appears that fish stocks in the Lower Shire have been impacted upon by over-fishing due to too many fishermen and modern methods. *Mputa, natemba, sintumbwe, nshira*, and *nsinkakala* have completely disappeared from Elephant Marsh in recent years (focus groups).

4.5.3.4 Control of the fishery

The fishery is currently open access with no licensing, but the Fisheries Department is trying to change this by establishing beach village committees and organising fishing rights (W. Waleru, pers. comm.). Policing is virtually non-existent, and officers do not have vehicles. Control is made more difficult by the fact that the majority of fishermen are farmers who are dispersed throughout the wetland, with very few actually fishing full time from regular spots (W. Waleru, pers. comm.).

A Fisheries Development Action Plan for the Nchacha community was developed in conjunction with the community (Banda 1998). The goal of the plan was, through the use of PRA, to identify ecological and socio-economic fishing problems the community were experiencing and to develop an action plan to solve them. The report generates no quantitative data that can be used in this study. It does, however, note that the problems experienced by the community, primarily the rapid decline in catch, were due to insufficient water in nearby fishing “lakes”, water hyacinth, the catching of juveniles through the use of mosquito nets, overfishing due to too many fishermen fishing continuously, and outsiders fishing in village “lake”.

No actions to mitigate these problems were being taken by the community due to the lack of fisheries extension advice on appropriate gear or closed seasons (Banda 1998).

4.5.4 Wild animals

As with the other wetlands of the ZBWCRUP, there have been large decreases in wildlife numbers during the last 150 yeas, particularly of plains mammals and those specifically associated with the wetlands such as sitatunga, lechwe, sable, reedbuck, bushbuck, waterbuck and elephant (Timberlake 1997). Today, Elephant Marsh contains little but Hippos and crocodiles (Timberlake 1997, FPO pers comm.). Elephants no longer occur in the local National Parks and Wildlife Reserves (F. Kalowekamo, pers. comm.), but elephant and buffalo still occasionally pass through the Marsh causing great excitement. Buffalo, which occasionally stray into the sugar plantations and villages near Lengwe National Park and Mwabvi Wildlife Reserve, are usually driven out or shot by government hunters (Timberlake 1997). The wetlands are still important to at least 64 bird species that utilise Elephant Marsh (Timberlake 1997).

18% of household survey respondents stated that they hunted wild animals. The vast majority of these catch hares, rats, doves, guineafowl and occasionally wild pigs. Large wading birds are netted or shot and smaller waterbirds like cormorants are a by-catch of gill netting. Occasionally, a hippo is shot by government officials. Considerable poaching of hippo is known to have taken place in recent years with meat being sold in local markets. The ZBWCRUP project has assisted the Department of National Parks and Wildlife to address this issue with the cooperation of traditional authorities. No households reported hunting for venison. Household surveys indicate that there is no variability in hunting effort over the year. 30% of households regard their intake of bushmeat to be insufficient. User households catch an average of 19 wild animals per year, mostly birds, spending an average 16 hours per year hunting. Animals were priced at the average price per bird of MK12.50. 17% of households sell about half their catch. The values associated with this harvest are summarised in Table 4.5.10.

Table 4.5.10. Annual values associated with the hunting of wild animals and birds in the Lower Shire wetlands, based on household surveys and focus group data

	MK Financial	Economic	US $ Financial	Economic
Average per user household:				
Gross value	236.18	236.18	5.28	5.28
Net value	58.42	44.44	1.31	0.99
Gross cash income	15.62		0.35	
Gross home value	220.56		4.93	
Gross returns to labour (per day)	118.09		2.64	
For whole wetland area:				
Gross value	2,466,938	2,466,938	55,127	55,127
Net value	610,199	464,134	13,636	10,372
Gross cash income	163,140		3,646	
Gross home value	2,303,798		51,482	

4.5.4.1 Wildlife conflicts

Local communities come into conflict with two wild species in the Lower Shire (Timberlake 1997, FPO: pers. comm.):

Hippos graze and trample crops grown on the wetlands, but have been reduced to very low numbers of about 450, counted in last census; (Timberlake 1997; village interviews).

Crocodiles are present in the wetland areas, although not in large numbers (Timberlake 1997). Recent (1998) counts done by the Department of National Parks and Wildlife indicate that there is a larger number of crocodiles in the Shire now than before. They are known to damage fishing nets and to attack humans, in many instances fatally.

The government culls hippos that are a problem and sells the meat to the villagers (village interviews). The villagers feel that they are losing out, and would prefer to have a hand in the management of such "problem" species, and this is the aim of the crocodile and hippo management plans being promoted by the project. Most people have guns, but they are not allowed to kill crocodiles and hippos (village interviews).

Thus, in general, wildlife may not make a positive contribution to the economy of the study area if these costs exceed the net financial benefits of US$13 600. To the individual affected by wildlife externalities, the net value of a little over a dollar will do nothing to offset costs incurred. As long as the negative externalities of wildlife exceed the individual benefits, declines in "problem" wildlife populations can be expected.

4.5.5 Wild plants

The natural vegetation of the Lower Shire valley provides for many of the subsistence needs of rural households, along with opportunities for sales, barter and enterprise development. Plant products include wood and timber products, leaves, fruits, nuts, barks, roots, tubers, reeds, sedges, grasses and medicinal plants (focus groups). Most homes are constructed with wood, mud, reeds, bamboo and thatching grass. Most households use upland firewood and poles for cooking and construction.

4.5.5.1 Reeds and Papyrus

Reeds are used extensively in the construction of buildings. They are preferable to bricks because brick houses subside on the wetland and the walls crack. Reeds are also used in the construction of granaries, doors and fences, as well as in the traditional fishery as traps, spears and rods (village meetings, focus groups). Papyrus is "used for everything inside the home", but is especially important in the production of sleeping, floor and drying mats. Papyrus is also used to line coffins.

Reeds and papyrus are harvested at the end of the flood cycle as floodwaters are receding (Fig. 4.5.6). By late October there are almost no reed and papyrus beds left, due both to excessive harvesting and the setting of fires to prepare agricultural lands and improve pasturage.

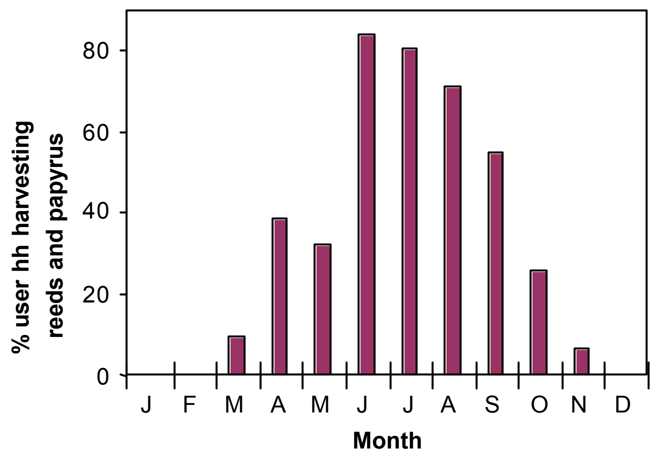


Figure 4.5.6. Proportion of Lower Shire user households harvesting reeds and papyrus during different months of the year (from household surveys).

A total of 66% of households reported harvesting reeds and papyrus, spending an average of 60 hours a year to collect 23.7 bundles. About 80% of poor and middle ranking households harvest reeds, as compared with only 24% of rich households., although there is no distinct trend in the amount collected by user households in different wealth categories. Harvesting is done by men, although women and children often aid in transporting bundles back to the homestead (focus groups). Only 11% of user households sell about half of their harvest at an average price of MK14.4 per bundle (range: K10-25, hh surveys and focus groups). The value of this activity is summarised in Table 4.5.11.

Table 4.5.11. Annual values associated with reed (phragmites) and papyrus harvesting in the Lower Shire wetlands, based on household surveys and focus group data

	MK Financial	MK Economic	US $ Financial	US $ Economic
Average per user household:				
Gross value	342	410	7.64	9.16
Net value	332	349	7.41	7.79
Gross cash income	17		0.39	
Gross home value	324		7.25	
Gross returns to labour (per day)	46		1.02	
For whole wetland area:				
Gross value	13,087,203	15,704,643	292,451	350,942
Net value	12,698,031	13,349,014	283,755	298,302
Gross cash income	667,320		14,912	
Gross home value	12,419,882		277,539	

Value added through processing

Papyrus mat-making is responsible for most of the value associated with the use of this product in the study area. About 20% of households in the study area are involved in the production of papyrus mats, making an average of 44 mats per household per year. Households spend 261 labour hours on mat-making. An average of one bundle of papyrus is used per mat (focus groups), with both men and women doing the weaving (village meetings, household surveys). Two thirds of producer households sell 75% of their mats at an average price of MK50 per mat (range MK35-100, focus groups). The value added by mats to papyrus use in the study area is given in Table 4.5.12.

Table 4.5.12. Annual values associated with papyrus mat-making in the Lower Shire wetlands, based on household surveys and focus group data

	MK Financial	MK Economic	US $ Financial	US $ Economic
Average per user household:				
Gross value	2,179	2,614	48.68	58.42
Net value	1,432	1,648	32.01	36.82
Gross cash income	1,008		22.51	
Gross home value	1,171		26.17	
Gross returns to labour (per day)	67		1.49	
For whole wetland area:				
Gross value	25,283,094	30,339,713	564,985	677,982
Net value	16,625,046	19,121,752	371,509	427,302
Gross cash income	11,692,778		261,291	
Gross home value	13,590,316		303,694	

Variability and sustainability

The models estimate that a total of 909 000 bundles of reeds and papyrus are harvested annually from the study area. Villagers in focus groups expressed mixed opinions on short-term availability and long-term trends in reed and papyrus harvests, dependent on village location and local circumstances. In Nsanje, the last few years have been poor ones with low water levels in 1996 leading to lower harvests. In 1997 there was a severe flood which washed away most of the reed and papyrus beds, which had not yet recovered by 1998 (Fig. 4.5.7). Villagers from Lisuli claim that there have been no changes to the beds surrounding the lagoon.

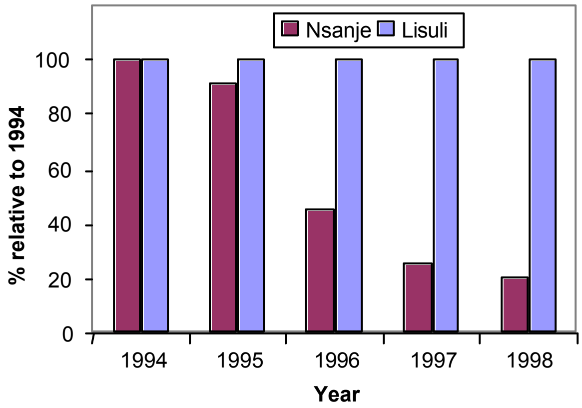


Figure 4.5.7. Lower Shire focus group perceptions of changes in reed and papyrus availability over the past five years

According to villagers in Nsanje, the long-term trend for reeds and papyrus has been one of sudden decline in the 1980s and low harvests since then (Fig. 4.5.8). Villagers from this area blame the huge influx of almost one million Mozambican refugees in the eighties for the decimation of once vast reed and papyrus stocks, saying that they have never recovered from excessive harvesting to build temporary houses (focus groups). Villagers from Lisuli say that reed harvests depend on long-term climate and other factors like farming. They say that in the eighties, harvests of floodplain resources dropped when large numbers of smallholders moved into Elephant Marsh after a series of drier than average years.

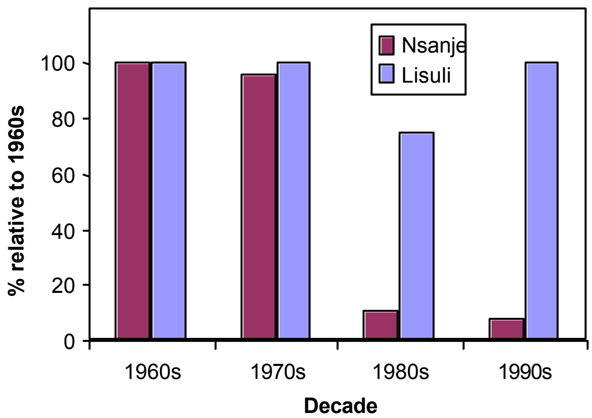


Figure 4.5.8. Lower Shire focus group perceptions of changes in reed and papyrus availability over the past four decades

Villagers from Kasisi used to collect all their own reeds, but due to scarcity, 50% of reeds now have to be bought from a distance (village meetings). They blame the scarcity on farmers having too many permanent gardens (smallholder cultivation) on the wetlands where reed and papyrus beds used to be.

4.5.5.2 Grass

Several species of floodplain grass are harvested in the study area. Grass is used primarily for thatching buildings and other structures, but is also used to make brooms, and as ties in mat-making and fish traps. A few species are also suitable to be woven into a number of products like baskets and hats.

Villagers in focus groups stated that most grass harvesting occurs at the beginning of the dry season, during the period when the floodwaters recede and immediately after (Fig. 4.5.9). The harvesting period is short and intense as villagers need to harvest the grass before the "burning season starts" (focus groups). Grass is often cut to order for people in the uplands and towns (focus groups).

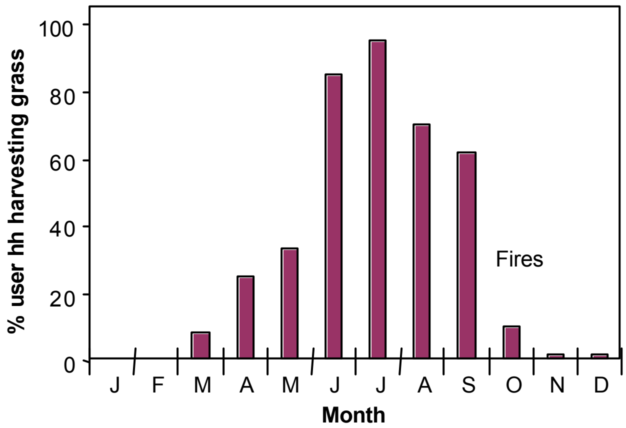


Figure 4.5.9. Proportion of Lower Shire user households harvesting grass during different months of the year (from household surveys)

Thatching grass is collected in bundles of about 40-50cm in diameter, usually by both men and women (focus groups). All bundles reported were standardised to 40cm. A total of 62% of households reported harvesting grass, spending an average of 106 hours a year to collect 93 bundles. More poorer (75%) and middle (67%) status households collect grass than richer households (36%), and among user households, poorer households collect more grass than richer households (Fig. 4.5.10). About 11% of user households sell about 10% of their harvest at an average price of MK25 per bundle (range MK10-40, focus groups). The value of this grass harvesting is summarised in Table 4.5.13.

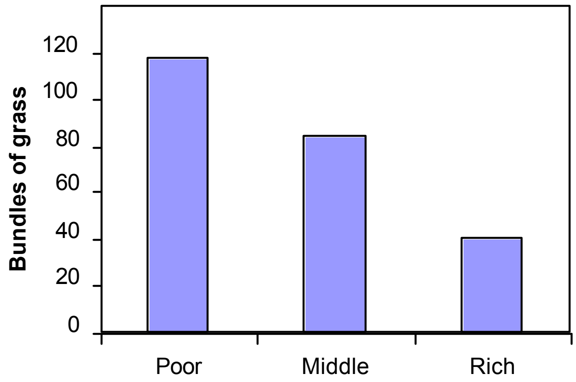


Figure 4.5.10. Average numbers of bundles of grass collected by Lower Shire households of different wealth status (household survey data).

Table 4.5.13. Annual values associated with grass harvesting on the Lower Shire floodplain, based on household surveys and focus group data

	Namibian $		US $	
	Financial	Economic	Financial	Economic
Average per user household:				
Gross value	2,330	2,796	52.06	62.47
Net value	2,322	2,698	51.89	60.30
Gross cash income	40		0.89	
Gross home value	2,290		51.17	
Gross returns to labour (per day)	176		3.93	
For whole wetland area:				
Gross value	83,819,232	100,583,078	1,873,055	2,247,667
Net value	83,535,561	97,081,645	1,866,716	2,169,422
Gross cash income	1,434,614		32,058	
Gross home value	82,384,618		1,840,997	

Value added through processing

About 11% of households in the study area are involved in the production of grass brooms, making an average of 9 brooms per household per year. About 6 labour hours per year are spent this way by producer households. 27% of producer households sell all their brooms at an average price of MK3.50 per broom (range MK2-5, focus groups). About 57 000 brooms are produced annually in the study area. The value added by brooms to grass use in the study area is given in Table 4.5.14.

Table 4.5.14. Annual values associated with grass broom-making in the Lower Shire wetlands, based on household surveys and focus group data

	Namibian $ Financial	Economic	US $ Financial	Economic
Average per user household:				
Gross value	32	38	0.70	0.84
Net value	12	13	0.26	0.29
Gross cash income	19		0.43	
Gross home value	12		0.28	
Gross returns to labour (per day)	44		0.98	
For whole wetland area:				
Gross value	201,069	241,283	4,493	5,392
Net value	74,322	83,513	1,661	1,866
Gross cash income	121,848		2,723	
Gross home value	79,221		1,770	

Variability and sustainability

Villagers believe that the harvesting of grass is completely sustainable in areas where farming is not too intense (focus groups). Areas of grass that are heavily harvested regenerated fully each year if there is good flooding and/or rainfall. As with reeds and papyrus, the increased incidence of fires due to the clearing of fields for crops and improving pasturage had led to the decline of grass abundance in some areas.

4.5.5.3 Wild foods

Numerous wild plants in the study area are harvested for a wide variety of purposes. *Nyika* is a common water lily bulb that acts as a bulk carbohydrate substitute during poor crop years, or for the months between harvests when grain supplies are running low. It is commonly found growing in the mud in marshy areas and pools on the floodplain. Large numbers of these plants thrive in the shallow water as floods recede. *Msinga* is a wild millet which also has a nutritious bulb. *Denje* and *thove* are two of over a dozen plants from which the leaves and seeds are used as relish to spice up meals. The roots, leaves and bark of another dozen or so trees and shrubs have medicinal uses. Numerous wild fruits also grow in the study area (focus groups)

According to villagers, the harvesting of some wild foods occurs while the floodwaters are receding and shallow pools are forming, while others are harvested throughout the year (focus groups). Analysis of household survey responses, however, shows that wild food collection is highly seasonal, mostly taking place after the flood and into the dry season (Fig. 4.5.11). The reasons for this are probably twofold. Most wild foods occur in areas that are not converted for farming, which tend to be areas flooded for several months a year, making collection impossible. Secondly, wild foods are most utilised when stable grains run short, which is usually at the end of the dry season (August-September).

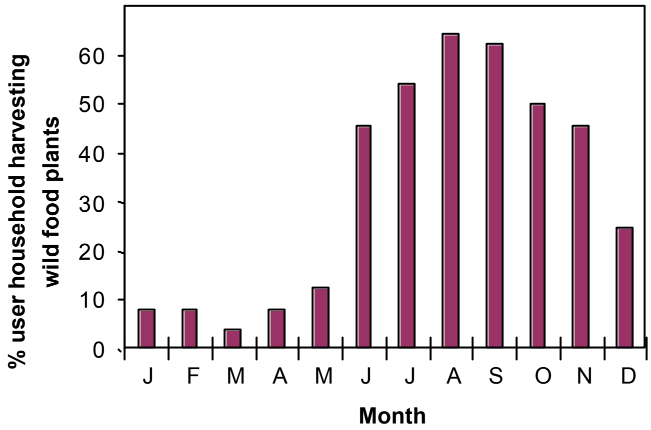


Figure 4.5.11. Proportion of Lower Shire user households harvesting wild food plants during different months of the year (from household surveys)

A total of 53% of households reported harvesting wild food plants, spending an average of 27.8 hours a year to collect 119kg. Harvesting is by women. 25% of user households sell all of their harvest at an average price of MK 5 per kg (sold at 50 tambala per no. 10 plate, which holds about 100g worth, focus groups). The value of this activity is summarised in Table 4.5.15.

Table 4.5.15. Annual values associated with the harvesting of wild food plants in the Lower Shire wetlands, based on household surveys and focus group data

	MK Financial	Economic	US $ Financial	Economic
Average per user household:				
Gross value	593	593	13.24	13.24
Net value	561	538	12.55	12.02
Gross cash income	220		4.92	
Gross home value	373		8.32	
Gross returns to labour (per day)	171		3.81	
For whole wetland area:				
Gross value	18,222,455	18,222,455	407,206	407,206
Net value	17,268,230	16,546,828	385,882	369,762
Gross cash income	6,766,144		151,199	
Gross home value	11,456,311		256,007	

Availability and sustainability

The model estimates that a total of 3500 tons of wild foods are harvested annually from the study area. While this is not significant when compared to the >100 000 tons of staple grains produced in the same area, this resource is critical for household survival for a few weeks each year before harvest time. Poor households in particular derive a large food security value from wild food plants.

Trends in the availability and harvest of wild plants may reflect localised issues rather than declines in stock. For example, the apparent decline in harvests for Nsanje for the past five years was attributed to the big flood in 1997 and the higher than average flood in 1998, making food plants unavailable for harvest (Fig. 4.5.12). In Livunso, the same 1997 flood was blamed for a poor harvest while in 1994 and 1996, good crop years implied that fewer food plants were collected.

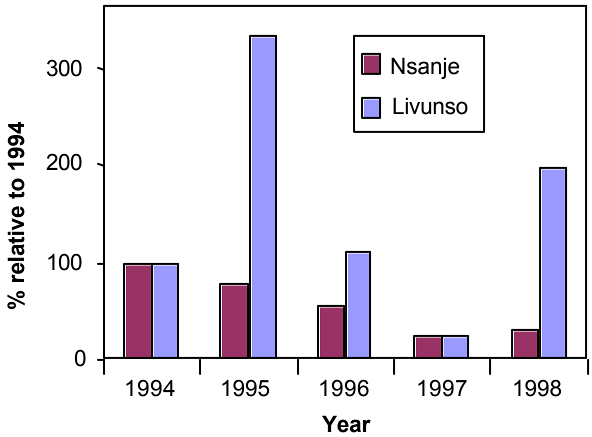


Figure 4.5.12. Lower Sire focus group perceptions of changes in wild food availability over the past five years

The apparent long-term decline for Nsanje was attributed to the fact that maize yields and market availability have increased significantly over the past two decades necessitating the use of less wild foods (Fig. 4.5.13, focus groups). Livunso villagers stated that stocks had not changed at all over the past four decades. In the 1960s commercial cotton and tobacco farms employed most people and there was enough money to buy food during shortages. In the 1980s there was a persistent drought which reduced the availability of wild foods. Current harvest rates seem sustainable to local people.

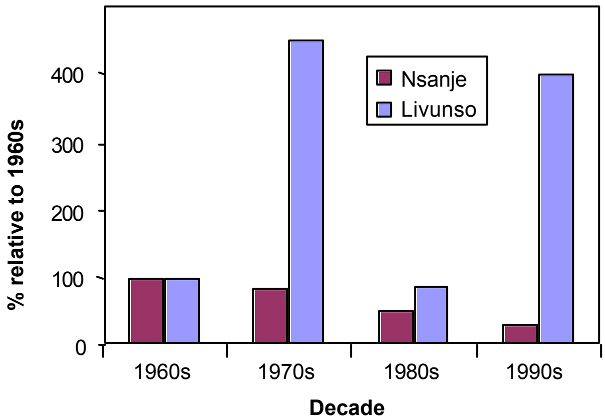


Figure 4.5.13. Lower Shire focus group perceptions of changes in wild food availability over the past four decades

4.5.5.4 <u>Palms</u>

Palm leaves are used by households in the study area in the production of baskets, brooms, hats and mats (focus groups). While no empirical data were gathered on palm frond harvesting in the study area, 5% of households reported using palm fronds to make baskets. Producer households make an average of 21 baskets per year, spending 209 labour hours per year on this activity. 80% of producer households sell all their baskets at an average price of MK30. About 62 000 brooms are produced annually in the study area. The value added by baskets to palm use in the study area is given in Table 4.5.16.

Table 4.5.16. Annual values associated with basket-making in the Lower Shire wetlands, based on household surveys and focus group data

	Namibian $ Financial	Economic	US $ Financial	Economic
Average per user household:				
Gross value	640	768	14.30	17.16
Net value	74	26	1.65	0.57
Gross cash income	560		12.51	
Gross home value	80		1.79	
Gross returns to labour (per day)	24		0.55	
For whole wetland area:				
Gross value	1,856,628	2,227,953	41,489	49,787
Net value	214,872	74,465	4,802	1,664
Gross cash income	1,624,571		36,303	
Gross home value	232,057		5,186	

4.5.5.5 Clay

While no empirical data was gathered on the harvest of clay in the study area, 15% of households reported using clay to make bricks. Producer households make an average of 1 200 bricks per year, spending 62 labour hours per year on this activity. One third of producer households sell a third of their production at an average price of MK2 per brick. About 10.5 million bricks are produced annually in the study area. Some 40% of households were constructed from earth and 20.5% from unburnt brick in the Lower Shire valley in 1993, indicating a high demand (CSR 1994). The value added by brick-making to natural resource use in the study area is given in Table 4.5.17.

Table 4.5.17. Annual values associated with brick-making in the Lower Shire wetlands, based on household surveys and focus group data

	Namibian $ Financial	Economic	US $ Financial	Economic
Average per user household:				
Gross value	2,408	2,890	53.81	64.57
Net value	722	1,151	16.12	25.72
Gross cash income	310		6.92	
Gross home value	2,098		46.89	
Gross returns to labour (per day)	311		6.94	
For whole wetland area:				
Gross value	20,959,958	25,151,950	468,379	562,055
Net value	6,280,540	10,017,188	140,347	223,848
Gross cash income	2,694,329		60,208	
Gross home value	18,265,628		408,170	

4.5.6 Ecotourism

There is very little tourism in the area. Most tourists visit the game reserves and Lengwe National Park, but evidence suggests that these parks are very under-utilised due to neglect. Some tourists do visit the area for birdwatching and other activities, but no quantitative data is available to allow estimate of value.

4.5.7 Overall use value and local perceptions

4.5.7.1 Annual use value

Perceptions of the importance of fish and other wetland resources relative to livestock, crops, upland resources and income from wage labour were obtained at village meetings as well as in the household survey. The perceptions of the first two villages (Chief Kasisi's and Mpokongola) were very similar. While agriculture is perceived as yielding half of all value accruing to households, fish and other wetland resources are perceived to provide 19-29% of value, on average exceeding the value of cattle production (Fig. 4.5.14). Perceptions obtained from the household surveys differed slightly from the village groups, mainly in that cash income was regarded as more significant, and crops were only perceived as being slightly more important than cattle. Income from fishing was also perceived to form a greater proportion of overall household income.

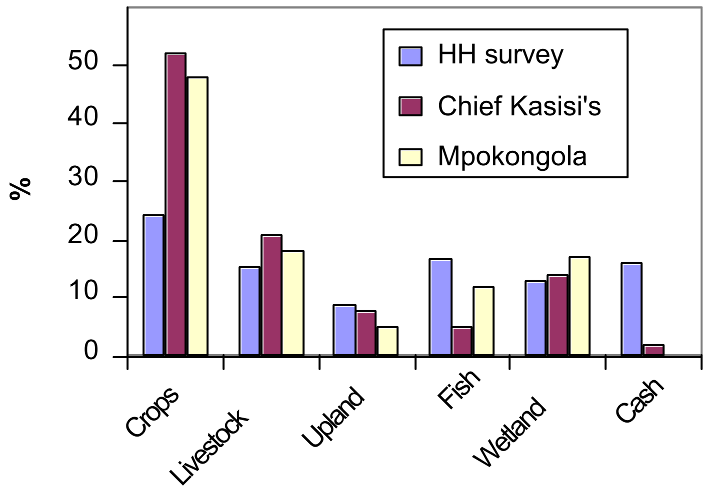


Figure 4.5.14. Perceptions of the relative annual value yielded by different agricultural and natural resources and wage labour, obtained from the household survey and from two village meetings in the Lower Shire. Numbers are % of beans allocated to each category.

A third village meeting was held at Nkhate, where a cooperative irrigation scheme is in place. These villagers, somewhat surprisingly, apportioned a lower value to crops (perhaps due to greater food security), but wetland and fish values were still 17-40% of perceived value (Fig. 4.5.15). There was some disagreement among the villagers as to whether crops or fish were more important. Fish were considered important because they are eaten every day, but crops were argued to be important because they earned money to pay for fish! According to some people, cattle and crops have always been more important than natural wetland products.

According to the elders, the relative values of agricultural and natural resource values did not change dramatically with the scheme (Fig. 4.5.15), and the main difference was that people earned income from working for colonial farmers in the past, in cotton and reed harvesting.

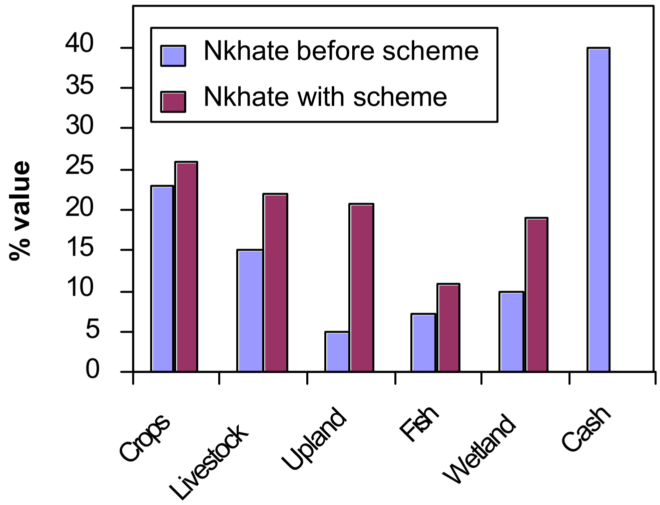


Figure 4.5.15. Nkhate villagers' perceptions of the relative annual value yielded by different agricultural and natural resources and wage labour, before and after the irrigation scheme was established (focus group data).

According to this study, crops are by far the most important source of value and cash income in the wetland, with fish generating the second largest values (Table 4.5.18). Other wetland resources, particularly grass, all generate substantial income to households, accounting for 15% of the gross economic value of the wetland. In all the wetland is estimated to be worth approximately US$24.6 million annually to the economy in terms of its gross use value, with a net economic value of US$19.8 million. Cropping makes up 63% and 67% of these values, respectively, with harvested wetland resources making up most of the remainder.

The relative values obtained in this study agreed fairly well with the perceptions of relative value given in the household survey (Fig. 4.5.16), except that cattle were found to be substantially less valuable, in relative terms, than perceived by the local people.

Table 4.5.18. Summary of current consumptive use values of the eastern Lower Shire wetlands

LOWER SHIRE	Cattle	Crops	Fish	Wildanimals	Reeds & papyrus	Palms	Grass	Wild foods	Clay	TOTAL
Average wetland hh (US$/y)										
Gross financial value	30.50	297.7	56.4	0.95	14.8	0.71	32.4	7.02	8.07	440
Net financial value	30.50	294.7	42.1	0.23	11.3	0.08	32.2	6.65	2.42	418
Gross cash income	2.07	44.7	14.6	0.06	4.8	0.63	0.6	2.61	1.04	69
Gross home value	28.43	253.0	41.7	0.89	10.0	0.09	31.8	4.41	7.03	370
Total wetland (US$ '000s/y)										
Gross economic value	2,124	15,518	3,926	55	351	50	2,248	407	562	24,630
Net economic value	2,006	13,270	1,730	10	298	2	2,169	370	224	19,854
Gross financial value	1,770	17,273	3,272	55	292	41	1,873	407	468	24,943
Net financial value	1,770	17,100	2,445	14	284	5	1,867	386	140	23,865
Gross cash income	120	2,594	849	4	15	36	32	151	60	3,766
Gross home value	1,650	14,679	2,423	51	278	5	1,841	256	408	21,178

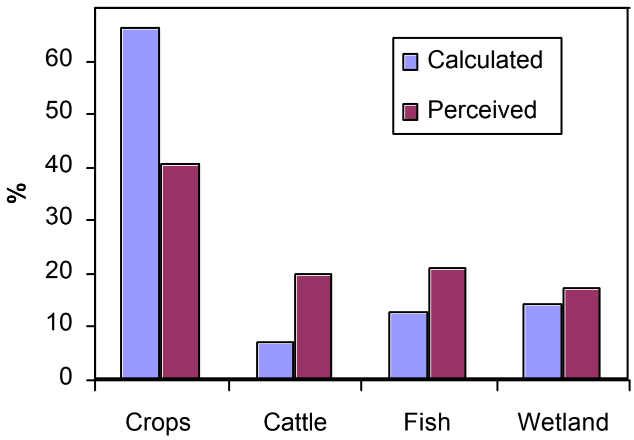


Figure 4.5.16. Relative measured value of crops, cattle, fish and wetland resources obtained in this study, vs their relative perceived value.

4.6 ZAMBEZI DELTA

This section presents use values for the whole Delta wetland study area, which is larger than the ZBWCRUP project area (see Chapter 3), and presents values for the latter in a summary table at the end. However, as values for the wetland area are simply extrapolated from household-level data, readers interested in values for the project area can easily calculate these from the tables as 74% of the value of the whole wetland area.

4.6.1 Livestock

No subsistence farmers in the Delta keep cattle. The only cattle herd in the study area is a herd owned by the Sena Sugar estate, and kept on Chinde Island. Only small livestock are kept, with an average of 5.8 chickens, 0.8 ducks, 0.3 goats and 0.4 pigs per household. The value of small stock is not calculated, because it is not a wetland value.

4.6.2 Crops

4.6.2.1 Subsistence agriculture

Soil fertility is generally high on the floodplains (Sweco 1982), and nearly all (99%) of rural households surveyed are engaged in subsistence agriculture. The average household cultivates 1.8 ha (household survey data), but average field sizes are larger in the inner Delta (2.54 ha) than the outer Delta (1.04 ha). Richer households have slightly larger fields on average, although household size is slightly smaller (2.0, 3.7 and 4.4 people for rich, middle ranking, and poorer households respectively). The main crops grown and areas under cultivation are summarised in Table 4.6.1, and yields and prices are in Table 4.6.2. The estimated total area of 110 000 ha of crops grown in the Delta is more than 50% higher than Schmidt's (1997) estimate for 1995/6.

Rice (*Arroz*)
The coastal zone north and south of the Zambezi is the largest traditional rice growing region in Moçambique. In the early 1980s about 30 000 ha of flood plain and marshy lowlands were occupied by 2-300 000 small scale rice farmers, taking up 90% of the cultivated area in the outer part of the Delta and 50-60% of the cultivated soils in the inner part of the Delta and on the coast south of the Zambezi (Sweco 1982). The current estimate of rice production area is 42 000 ha (Table 4.6.1). A good crop is 8-9000kg/ha, but subsistence yields can be about 540 kg/ha (Sweco 1982), and an average yield of 670 kg/ha was recorded in this study. Most rice in the coastal area is cultivated between rows of coconut palms on ridges of sandy soil, with other crops planted on the slopes. This type of cultivation covers vast areas near Quelimane, but is not extensive in the Delta. The most common type of rice cultivation in the Delta is on river banks which have been cleared of mangrove forest. This rice cultivation represents one of the worst threats to mangrove vegetation in the Delta region. Rice cultivation in the mangrove zone is sometimes on elevated ground, above the high tide level, which is surrounded by mudflats and mangroves.

Table 4.6.1. The main crops grown in the Delta study area, mean field size, total area, and their reported yields and prices (household survey data).

	Inland Delta		Coastal Delta			
Crop	% farmers	Mean area per hh (ha)	% farmers	Mean area per hh (ha)	Total area (ha)	% area
Rice	96	0.9	100	0.4	41 651	37.8
Maize	96	0.7	0	-	20 826	18.9
Sweet potatoes	65	0.36	89	0.33	15 896	14.4
Cassava	48	0.4	64	0.3	12 580	11.4
Sorghum	61	0.45	5	0.18	8 616	7.8
Millet	63	0.32	18	0.28	7 717	7.0
Sugar	15	0.32	5	0.25	1 882	1.7
Beans	7	0.3	2	0.5	826	0.7
Tobacco	2	0.25	0	-	153	0.1
TOTAL					110 147	

Table 4.6.2. Annual crop yields and prices (household survey data)

Crop	Yield (kg/ha)	Estimated total production (tons)	Price per kg (Mt 1999)
Rice	668	27 823	1611
Maize	642	13 362	1100
Sweet potatoes	698	11 100	800
Cassava	481	6 049	1200
Sorghum	407	3 509	1500
Millet	354	2 728	2500
Sugar	607	1 142	4000
Beans	245	202	3000

Maize (*Milho*)

Maize is a major subsistence crop in the area. In 1969 the average yields were 500kg/ha for traditional farms and 940 kg/ha on commercial farms. Current yields are about 640 kg/ha (Table 4.6.2). Maize is sown in October to December on higher ground and in June to July in lower-lying areas. Along the Zambezi maize is planted on sites where the crop can utilise the receding water table. Producer prices are very low, but increase dramatically during the period of food shortage from December to February.

Sweet Potato (*Batata doce*)

These are recorded by Sweco (1982) as important in the Lower Zambezi Valley, but are fairly insignificant in the Delta itself. However, this study found sweet potatoes to be widely grown, especially in the outer Delta, and this crop constitutes a large proportion of the total area (Table 4.6.1).

Cassava (*Mandioca*)

This is the most important food crop in Moçambique, and is grown extensively throughout the Delta.

Sorghum (*Mapira*)

This is cultivated primarily on dry, high lying areas. On the floodplains it occupies about 30% of the area close to the river between Mutarara and Marromeu (Sweco 1982), but it is of little importance elsewhere. Very little is grown in the coastal regions (Table 4.6.1).

Bulrush millet (*Mexoeira*)
This crop is mainly grown along the river between Sena and Marromeu (Sweco 1982).

Using data in Barbosa *et al*. 1997, the total average annual consumption of major foodstuffs was estimated for the study area (Table 4.6.3). This illustrates the relatively high diversity of the food base. Apart from the consumption of fish, wild animals and plants do not form a significant part of household consumption. The estimates of total production of the two main crops (Table 4.6.2) are significantly higher than the estimated demand. Estimated production of sweet potatoes and cassava is similar to demand, but estimated millet and bean production is far less than the demand, suggesting that production estimates from the household surveys may be too low.

Table 4.6.3. Average wet and dry-season consumption of different foods for seven villages in the study area (calculated from data in Barbosa *et al*. 1997a - g), and the estimated total demand for these products. All units are kg, except fish, in numbers.

Product	Wet season average per household	Dry season average per household	Total per household per annum	Estimated total demand per year
Rice	57.5	60.0	117.5	8 225 000
Maize meal	47.5	31.2	78.7	5 505 500
Sweet potato	76.7	88.5	165.2	11 561 667
Cassava	44.0	58.3	102.3	7 163 333
Millet	73.5	110.0	183.5	12 845 000
Sugar	2.0	1.8	3.8	262 500
Cane	0.0	32.0	32.0	2 240 000
Beans	50.7	50.8	101.4	7 098 000
Groundnuts	0.0	4.0	4.0	280 000
Vegetables	137.3	119.4	256.7	17 969 000
Madunco	40.0	20.0	60.0	4 200 000
Fruit	59.0	56.0	115.0	8 050 000
Coconut	18.0	18.0	36.0	2 520 000
Fish	74.2	55.4	129.6	9 072 000
Meat	8.8	23.2	32.0	2 240 000
Salt	0.8	1.0	1.8	122 500

Based on the household survey data, we estimate the current gross annual value of production for the major crops in the study area to be about US$7.4 million (Table 4.6.4), or US$68 per ha on average. This is similar to the economic value of US$5-10 million for crops that was estimated after the 1978 flooding, when 59 000 ha of mainly traditional agricultural land was destroyed (revised estimate by Sweco, 1982).

Table 4.6.4. Annual value of crop production in the Zambezi Delta

	Meticais		US $	
	Financial	Economic	Financial	Economic
Average per household:				
Gross value	1,530,394	1,532,290	122.43	122.58
Net value	1,528,140	780,036	122.25	62.40
Gross cash income	90,010		7.20	
Gross home value	1,440,384		115.23	
Gross returns to labour (per day)	3,826		0.31	
For whole wetland area:				
Gross value	92,919,766,594	93,034,901,427	7,433,581	7,442,792
Net value	92,782,914,094	47,360,861,435	7,422,633	3,788,869
Gross cash income	5,465,058,688		437,205	
Gross home value	87,454,707,906		6,996,377	
Gross returns to land (per ha)	850,219	851,272	68.02	68.10
Net returns to land (per ha)	848,967	433,353	67.9	34.7
Cash returns to land (per ha)	50,005		4	

4.6.2.2 Commercial agriculture

A dominant agricultural feature of the Delta is the Sena Sugar estate, which was operational until the 1980s, when it was abandoned due to the war. The Sena Sugar estate comprised 14 000 ha of rainfed sugar in Marromeu and 10 000 ha in Luabo, of which 7000 ha was irrigated. Production of raw sugar from this estate grew from 158 000 tonnes in 1977 to 178 000 tonnes in 1981. There were two mills, one at Marromeu and one at Luabo, both of which were destroyed during the civil war. Foreign investors have now begun to re-establish the estate, but it is not yet in production. Before the war, there were also plans to develop a total of 45 000 ha in the Mopeia Luabo area and 54 000 ha in the Marromeu area for irrigated agriculture (Burep report). The development would have taken place up to 1990 and would have produced export crops. New plans are currently being considered.

Several large private coconut plantations were planted in the Delta region. Although the enterprises were abandoned in the war, most of the trees remain, and some are being utilised again. Production of copra, or dried kernels of coconut, in 1981 was 28 400 tonnes. The trees were considered old in 1982, but replanting was taking place with Philippine hybrids at a slow rate of about 200 ha per year.

Very little value is currently being realised from commercial agriculture in the Delta. However, there is clearly huge potential value that could be realised, and this needs to be investigated, along with the potential opportunity cost, including conservation cost, associated with these developments.

4.6.3 Fish and crustaceans

There is a general shortage of animal protein in Moçambique, and fish is an important part of the diet. Fish of the Lower Zambezi River have been described by Jubb (1967) and Willoughby & Tweddle (1978). The DNFFB (1998) inventory of fish resources of the Delta was compiled from existing information on primary and secondary production and based on data collected in Tete province. The fish fauna of the Zambezi comprises 134 species, of which 17% are endemic, but within the lower Zambezi it is relatively poor, with about 60 species in 35 genera. These are listed in Willoughby & Tweddle (1978), Sweco (1982) and DNFFB (1998), and many of the larger species are illustrated and described in detail in Sweco (1982).

4.6.3.1 Species and catch methods

In the Pinda and Mopeia co-operatives, catfish *Clarias* sp. and cichlids, mostly *Tilapia* or *Saratherodon* spp., make up about 90% of the catch (Sweco 1982). Catches in Marromeu Buffalo Reserve are dominated by *Labeo cf. congoro*, *Tilapia* sp., *Tilapia melanopleura*, *Hydrocynus vittatus*, *Clarias gariepinus* and *Clarias imberi*. *Alestes imberi* was abundant but was reported to be disappearing in the early 1980s (Sweco 1982). The main fish targetted by fishers in the Delta, as reported by fishers, are listed in Table 4.6.5.

Table 4.6.5. Fish species named by fishers in focus groups in three villages. Safrique is in the inner Delta, Chueza is on the Zambezi in the inner Delta, and Chinde is at the coast.

Freshwater species	Scientific name	English name	Safrique	Chueza	Chinde
Nsomba, Bagre	*Clarias gariepinus*	Sharptooth catfish	✔	✔	✔
Makakana					✔
Mujirire					✔
Masimbwe/Masimbo				✔	✔
Mcheni, Muiene	*Hydrocynus vittatus*	Tiger		✔	✔
Mamono					✔
Mpende/Pende	*Tilapia placida,, T. mossambica*			✔	✔
Nkupe, Mucupe	*Mormyrus longirostris*			✔	✔
Machenicas/Machenia				✔	✔
Korokoro	*Synodontis zambezensis, S. nebulosus*	Squeaker		✔	✔
Dande, Madande,	*Schilbe mystus, Eutropius depressirostris*	?Big mouth		✔	✔
Nentje		Bottlenose?		✔	
Mamputa = Mapatu?	*Cyphomrus discorynchus*	?Mudfish		✔	
Marine species					
Malola					✔
Bacre					✔
Corovina					✔
Ninjemacrance					✔
Camaroes (2 types)		Prawns			✔
Methezi					✔
Caranguejo		Crabs			✔

Fishing is practised by artisanal fishers, using canoes, nets, lines, circle traps (*cerca*) and basket traps (*gayola/matumba*). At the coast, seine nets or dragnets (*rede puxar*) are also used, for prawn fishing. Fishermen concentrate in small fishing camps along the river banks, producing fresh, dried or smoked fish (DNFFB 1998). Most of the registered fishing camps are found in the Chinde district. The fifteen camps in this area contain 305 canoes and an additional 62 fishers without canoes.

Of the fishers in the household survey, 67% owned or use canoes, 44% have gillnets, and 35% use lines. Another 6% said they fished using traps and 2% said they used seine nets. Both gillnets and seine nets reportedly cost about Mt200 000, while fishing line is about Mt1000-2000 per metre. Canoes represent an investment of about Mt500 000.

4.6.3.2 Seasonality, effort and catch

On the floodplain, most fishing effort is concentrated during August to December, when floodwaters have receded (Fig. 4.6.1). Along the main river channel, fishing effort is spread over April to October, starting earlier, when floodwaters are still receding. Fishing effort is spread over a similar period at the coast, but fishers move from the wetland to the sea around June, probably due to decreasing catch per unit effort at this time, relative to marine catches.

At the coast (outer Delta), about 37% of the catch comes from the marine environment, and a further 24% from the estuarine environment (Fig. 4.6.2). In the inner Delta, a greater proportion of the catch comes from major river channels than from the floodplain wetlands (Fig. 4.6.2).

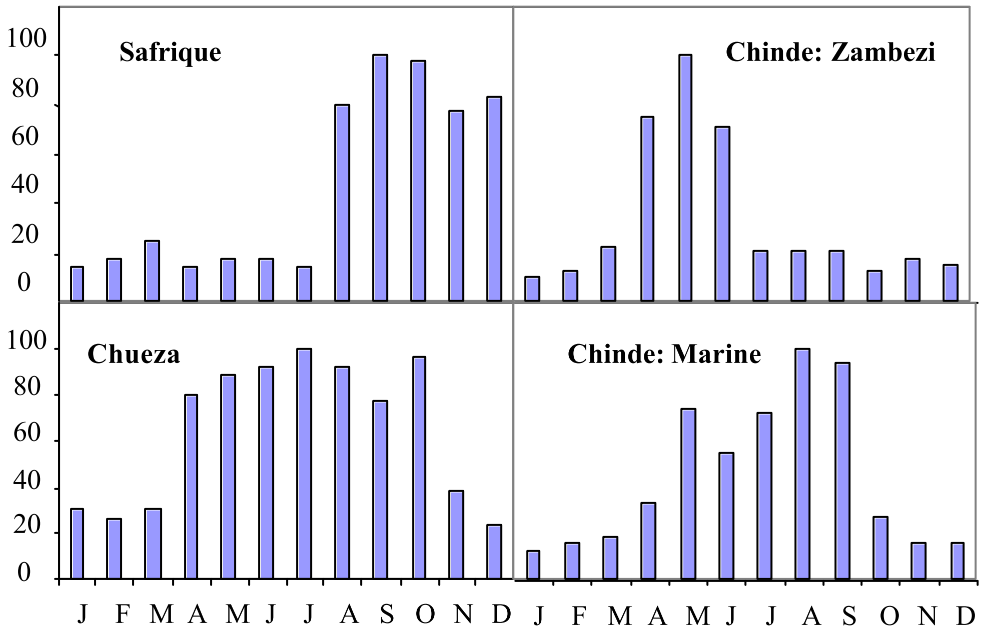


Figure 4.6.1. Seasonality in fish availability and effort as reported by fishers in focus groups, in Safrique, a floodplain village, inner Delta, Chueza, on the Zambezi, inner Delta, and in Chinde at the coast. The latter is divided into the freshwater and estuarine fishery (Zambezi) and the marine fishery.

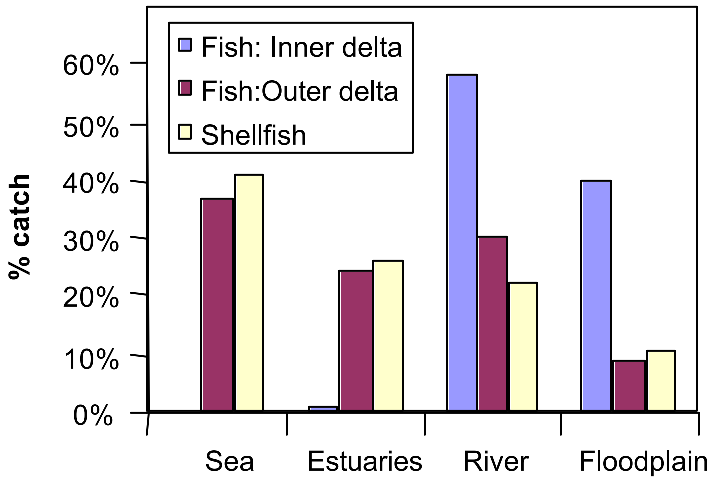


Figure 4.6.2. Proportion of catch from different habitats in the inner and outer (coastal) regions of the Delta, as reported by fishers in the household survey. Crustaceans are only caught in the coastal regions.

Prior to this study, there have been no comprehensive studies of the size of the Delta fishery. Subsistence catches do not enter the official statistics. The DNFFB (1998) estimated a total catch in registered camps in Chinde district to be 645 tons (Table 4.6.6). However, this only represents the catch of a proportion of the full-time, commercial fishermen of the Delta, and these catches are greatly exceeded by part-time subsistence fishermen throughout the Delta (see below).

Table 4.6.6. Fishing effort and catch in registered camps in the Chinde district (based on DNFFB 1998).

Fishing method	Number registered	Effort per fisher per day	Mean catch per fisher per day (kg)	*n*	Estimated total annual catch per fisher (kg per 150 days)	Estimated total annual catch (kg)
Drag net (*Arrasto)*	12	2 drags (1h each)	0.89	1	133.5	1 602
Line (*Linha)*	98	2h or more	26.5	1	3975	389 550
Gill net (*Emalhe)*	205	2-3 h, some overnight	6.1	3	915	187 575
Circle trap (*Cerco)*	47	2-3 h	9.4	2	1410	66 270
TOTAL						644 997

Welcomme (1978) calculated an average catch estimate of 38 kg/ha per year for 12 African floodplain fisheries (excluding the Zambezi). Using this average, and assuming a flooded area of 500 000 ha, the lower Zambezi would thus yield about 19 000 tons per year. Based on the fact that much of the Delta is inaccessible, Sweco estimated that the actual catch would probably be lower, about 10 000 tons (Sweco 1982).

In this study 78% of inner and 66% of coastal outer Delta households were engaged in fishing, excluding crustaceans. There was no difference in numbers of households of different wealth classes that fish in inner areas, but at the coast, more poorer households (70%) fish than middle and richer households (47%). Fishing households in the inner Delta reported an average annual catch of 267kg, while those at the coast caught 714kg of which 450kg came from the Zambezi wetlands, and the remainder from the sea (37%). Apart from the marine catch, the total catch in the Delta is estimated as 15 610 tons. A large proportion (69%) of fishing households sell part of their catch. Fish currently sell for between 2000 and 5000 Mt per kg, depending on species and whether fresh or dried. The value of fishing, excluding the marine catch, is summarised in Table 4.6.7.

Table 4.6.7. Value of the freshwater and estuarine fish harvests in the Delta

	Meticais		US $	
	Financial	Economic	Financial	Economic
Average per fishing household:				
Gross value	1,434,000	1,720,800	115	138
Net value	1,375,575	1,500,143	110	120
Gross cash income	747,132		60	
Gross home value	686,868		55	
Gross returns to labour (per day)	17,595		1	
For whole wetland area:				
Gross value	62,442,063,399	74,930,476,079	4,995,365	5,994,438
Net value	59,898,012,907	65,322,209,674	4,791,841	5,225,777
Gross cash income	32,533,098,822		2,602,648	
Gross home value	29,908,964,576		2,392,717	

Our model suggests that the gross economic value of the Delta fishery is US$6 million. This is less than the estimate of US$8 million made by Sweco (1982), applying a standard value per kg used by Mozambican authorities in calculating the economic return of fisheries to their estimated catch of 10 000 tons.

The crustacean fishery yields a further gross value of US$1.35 million (Table 4.6.8). A total of 27% of households in the outer Delta are involved in crustaceans harvesting, as compared with 2% of households in the inner Delta, with no discernible influence of wealth status on crustacean fishing activity. Fishing households obtain an average of 328 kg per year, not including marine catch, and 69% of households sell part of their catch, at an average price of Mt 5000 per kg.

Table 4.6.8. Value of the crustacean catch in the Delta

	Meticais		US $	
	Financial	Economic	Financial	Economic
Average per crustacean fishing household:				
Gross value	1,639,000	1,966,800	131.12	157.34
Net value	1,565,452	1,785,908	125.24	142.87
Gross cash income	258,750		20.70	
Gross home value	1,380,250		110.42	
Gross returns to labour (per day)	28,629		2.29	
For whole wetland area:				
Gross value	14,072,677,498	16,887,212,997	1,125,814	1,350,977
Net value	13,441,183,523	15,334,050,947	1,075,295	1,226,724
Gross cash income	2,221,662,784		177,733	
Gross home value	11,851,014,714		948,081	

4.6.3.3 Variability and sustainability

Fishers in all three focus groups reported that fishing was good in years of good floods, and poor in years of low floods and high rainfall. In Safrique, fishers claimed that the past three years had had good floods, whereas in Chueza, they said good floods had occurred in the past two years (FIg. 4.6.3).

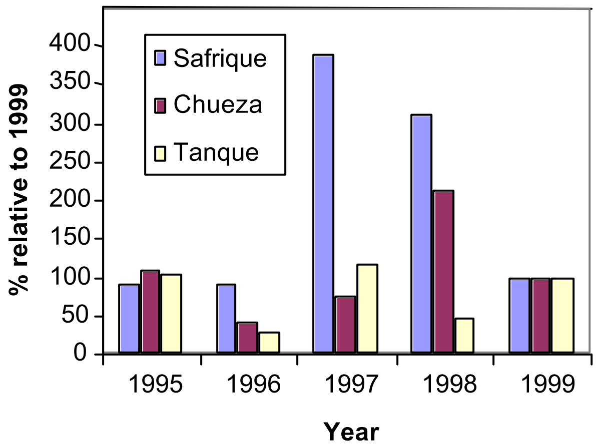


Figure 4.6.3. Delta focus group perceptions of variability in catches over the past five years.

On the basis of Welcomme (1978), the fishery may have the potential to expand. However, this estimate does not take into account the fact that the flooding regime of the Delta has been seriously altered, and productivity of the system may thus be far lower than 38kg/ha. According to fishers in focus groups, catches were far better in the 1960s and 1970s than in the last two decades (Fig. 4.6.4), which suggests that stock size has declined. Fishers claimed that the reason for the decline was both the change in flooding regime due to Cahora Bassa, and the increase in numbers of fishers. This does not necessarily mean that the fishery has been overexploited to a point where current catches cannot be maintained. However, with increasing population, and little management of effort in the fishery, it is quite conceivable that this may occur in the future. Only a detailed study of the fishery will allow an assessment of its sustainability.

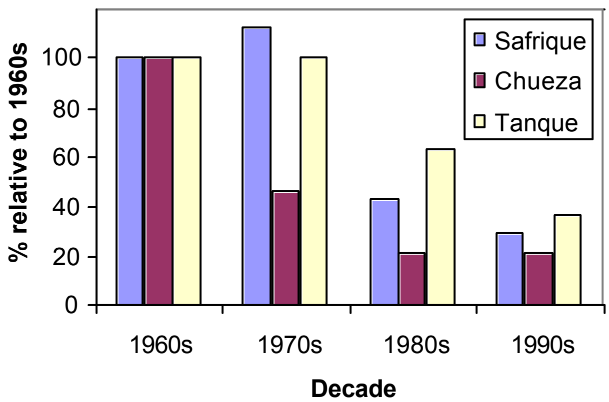


Figure 4.6.4. Delta focus group perceptions of changes in fish availability over the past four decades

Fishing is regulated, at least in theory, by means of a licensing system, with licences for nets being available from the Department of Agriculture for Mt75 000. If fishers are caught without a licence, the nets are confiscated, which amounts to a considerable loss in cash terms. However, focus groups also mentioned that monitoring is scarce, and in Safrique, fishers were under the impression that there are no fishing regulations at all.

According to the DNFFB (1998), to retain a diversity of natural fish stocks, certain areas will have to be maintained as reserves, and suitable hydrological conditions will have to be maintained, as the fish fauna is sensitive to the hydrological regime of the river. While acknowledging that some traditional methods are as efficient as more sophisticated methods for catching certain fish, DNFFB (1998) suggest that the introduction of new fishing methods or improvement of existing methods and introduction of faster boats will increase the quantity of catches. However, this suggestion should be viewed with caution, as overcapitalisation in the fishery would undermine some of the high resource rent that is currently generated. They also suggest fish culture as an ideal land use, which could be introduced in the wetlands adjacent to the river, and suggest that regions of the Zambezi should be considered for the semi-intensive cultivation of prawns. While such activities are attractive in terms of their financial returns, great caution should be exercised in advancing such ideas, as the negative externalities, and thus full economic costs, associated with aquaculture in wetlands can be high.

4.6.4 Wild animals

Wild animals occupy the grass plains and move to the uplands when the former become too wet. These plains cannot be used efficiently for cattle, because of the distances they have to be moved. The southern part of the Delta was rich in game, while the more accessible northern part had less game. Numbers were high around Independence in the early 1980s, but most wild animal populations have now been severely reduced, if not decimated (e.g. Hatton & Munguambe 1997).

In the 1970s, it was estimated that the Marromeu Buffalo Reserve could produce 320 tonnes of meat per year if 10% of the total was cropped each year (Tinley 1975). In the 1980s, game was cropped at about 2.5%. This is lower than the maximum possible under good conditions (10%) or average conditions (5%). In the early 1980s, the average annual yield was estimated to be 400 tonnes, valued at US$ 0.4 million (Sweco 1982).

In the DNFFB (1998) inventory report, wildlife resources were assessed by means of aerial surveys and ground transects in a selected area of about 400 000 ha including Coutada 14, the Marromeu Buffalo Reserve, and a free zone in the north of the Delta (Mopeia and Chinde districts; Table 4.6.9).

These were given as preliminary estimates, because much of the study area had been recently burnt, and some observers were novices. The quotas can thus be used as minimum estimates (DNFFB 1998). The lower diversity in the north was attributed to low visibility due to fire smoke and time of day. Observations in the south took place early in the day and in conditions of excellent visibility. Low numbers of some species are attributable to their behaviour. Zebras were not observed, but are reported to be seen occasionally.

Table 4.6.9. Wild animal population estimates and recommended annual harvest quotas (DNFFB 1998).

Species	North of Zambezi Estimated population (confidence range)	Recommended annual quota (5%)	South of Zambezi Estimated population (confidence range)	Recommended annual quota (5%)
Warthog	263 (204-322)	10	297 (255-339)	13
Reedbuck	378 (349-407)	17	506 (430-582)	22
Waterbuck	168 (119-217)	6	109 (53-165)	3
Oribi			100 (86-114)	4
Eland			262 (114-410)	6
Buffalo	189 (136-242)	7	7657 (4546-10508)	90 (2%)
Sable	126 (101-151)	5		
Bushbuck	21 (14-28)	4*		
Grey duiker	8 (5-11)	10*		
Elephant			589 (338-840)	3
Wild Pig			21 (8-34)	10*
Baboon			109 (58-160)	30*
Lichtenstein's hartebeest			44 (43-69)	2
Honey Badger			12 (6-18)	0
Hippopotamus			12 (6-18)	1
Crocodile			12 (6-18)**	10 #

* The total population is probably much higher than estimated
# Problem species which should be largely reduced
**DNFFB (1998) estimate a total population for the Delta as 100 crocodiles, therefore the above data presumably do not include the Zambezi itself.

Potential maximum annual growth rates of many of these species, when managed for production, are estimated to be considerably higher than 5% (e.g. Buffalo 15%, Hippo 10%, Sable 10%, Waterbuck 18%, Reedbuck 25% - Anderson *et al*. 1990), but an offtake rate of 5% or less would allow recovery of the populations. It must be noted, however, that drier conditions due to river control are favouring bush encroachment, which may lead to more mixed feeders and less grazers, and wetland yields may be reduced. At this stage, only one or two hunting lodges are operational in the region. The potential economic value of this offtake needs to be estimated by means of construction of commercial and subsistence hunting models. Such an undertaking will require an accurate estimation of current market price and cost data.

The DNFFB recommend that there should be annual inventories, both during dry and wet seasons, to keep track of increases. Measures must be taken to assure the conservation of resources in the northern Delta to the advantage of the local communities. The operators of Coutada 14 will need to initiate a scheme of community involvement in the adjacent area.

There is the need to ensure that communities gain from wildlife management in the area. Quotas should be allocated to the local communities who can then negotiate with safari operators and gain benefits from the wildlife that affects their lives, and it may be necessary to reduce the number of crocodiles in the region to increase human safety (DNFFB 1998).

There is no data on household consumption of wild animals in the Delta. Northwest of the Delta, about two-thirds of households regard their venison/meat intake as insufficient, and less than 12% of households get most or all of their meat from hunting (Schmidt 1997). In this study, focus groups in three areas denied that anyone does any hunting of any wild animals. This activity is illegal, however, making it difficult to obtain honest responses. However, 10% of respondents in the household survey claimed to hunt antelope, rats, birds and collect honey. The value of this harvest is summarised in Table 4.6.10.

Table 4.6.10. Value of wild animal harvesting among rural households in the Delta

	Meticais		US $	
	Financial	Economic	Financial	Economic
Average per user household:				
Gross value	55,200	55,200	4.42	4.42
Net value	24,385	9,315	1.95	0.75
Gross cash income	19,698		1.58	
Gross home value	35,502		2.84	
Gross returns to labour (per day)	9,316		0.75	
For whole wetland area:				
Gross value	338,539,091	338,539,091	27,083	27,083
Net value	149,550,078	57,130,286	11,964	4,570
Gross cash income	120,806,939		9,665	
Gross home value	217,732,152		17,419	

4.6.5 Wild plants

An inventory of wildlife and forestry resources in the Delta was recently carried out by the Department of Forestry and Wildlife (DNFFB 1998) as part of the IUCN's ZBWCRUP. This follows an earlier, in depth study by the DNFFB (1997a, b). The area inventoried for forest resources by the DNFFB (1998) covers approximately 57 500 ha. The DNFFB report (1998) provides information on the potential of natural resources existing in the project area from the coast to the confluence with the Shire River, recognising sustainable levels of harvest and the establishment of systems of control and monitoring. In addition, the DNFFB is developing a five-year management plan for the Gorongosa-Marromeu area which aims to promote the conservation and sustainable use of natural resources in such a way as to reinforce the local and national economy. This will put a new perspective on the conservation of biodiversity in the area.

There is little information on the human use of natural resources, however (Schmidt 1997). Principle natural resources used are posts, poles and bamboo's for construction, covering/thatching materials, medicinal plants, firewood, palm wine, honey, fish, venison and water (DNFFB 1997b, Schmidt 1997). It was realised that certain communities, for example Marromeu, depend to a large extent on the sale of natural resources (DNFFB 1997b), and 3% of households in Marromeu sell firewood (Lof & Hendersohn 1996).

Pressure on natural resources increases during times of food shortage and crop failure, and generally reaches a peak in December to February, before the first harvest. Harvesting is for subsistence use and for supplementing incomes. The time of peak exploitation coincides with the beginning of the rainy season, a period of peak natural production. Plant growth and recovery is fastest during this period, and fish are at their most abundant (SCF 1995a in Schmidt 1997).

The levels of natural resource use in the different districts as reflected by the numbers of licences issued, is shown in Table 4.6.11. Licences are issued by provincial and district authorities. There is little provincial level control in Chinde, due to its inaccessibility, thus fishing and wood harvesting is regulated entirely at a district level. Hunting licenses cost 289 500 Meticais (about US$24). The number of licences are likely to underestimate total user numbers.

Table 4.6.11. Licences for natural resource use, issued at a district or provincial level (Schmidt 1997).

	Mopeia	Chinde	Marromeu
Wood cutting	14	6	0
Fishing licences	30	1000	2
Hunting licences	17	11	11

Three major types of forest resources were inventoried in the Delta by the DNFFB (1998): woodlands, *Borassus* palm communities and Mangroves. The commercial volume harvestable from the woodland areas was estimated to be 17.3m^3 per ha on average, mostly comprising *Millettia stuhlmannii* (Panga-panga) and *Pterocarpus angolensis* (Umbila). However, potential production forest in Sofala and Zambézia largely falls outside of the Delta proper (Hatton & Munguambe 1998), although it surrounds the wetland and so probably forms an integral part of the Delta economy. Wetland resources are discussed in detail below.

4.6.5.1 Mangroves

The mangroves in the Delta are of international significance; with most mangroves in Africa being found in Moçambique, Tanzania and Kenya. The total area of mangroves in Moçambique is about 396 000 ha (125 317 ha in Sofala and 155 757 ha in Zambézia, Saket & Vasco Matusse 1994), much of which falls within the Delta region. The mangroves have been mapped using aerial photography in the 1950s and 1970s (Hidrotecnica Portuguesa 1961, Loxton, Hunting & Associates 1975), but discrepancies in the classification of the vegetation between the two studies makes comparison difficult (Sweco 1982). The mangroves were mapped again using Landsat imagery in 1981 (Sweco 1982).

Mangroves are important in that they provide ecological, economic and environmental benefits to communities and to society in general (Tomlinson 1986, DNFFB 1998). Mangroves are recognised as having an important role in protecting coasts, moderating the effect of storms, protecting habitats, reducing excessive pollutants, providing opportunities for education, scientific research, recreation and tourism (DNFFB 1998). The DNFFB (1998) inventoried 5 500 ha of mangroves in the Delta. The main species found, and their uses, are listed in Table 4.6.12.

Certain species (e.g. *Heritiera, Xylocarpus*) produce wood of high quality, density and resistance to termites. All the species except *T. popunea* are considered to be important forestry resources, in that they produce valuable timber (DNFFB 1998). Seven zones were sampled by DNFFB (1998), and the overall average volume of timber was estimated as 149.6 m^3/ha (DNFFB 1998). The overall size distribution of mangrove trees is given in DNFFB (1998). Mangrove vegetation has a high regeneration and propagation capacity, and harvest potential is thus high.

Table 4.6.12. Main mangrove tree species in the Delta and their relative abundance (calculated from DNFFB 1998**).**

Species	Local name	Relative abundance (%)	Uses
Avicennia marina	*Invede*	31.9	Firewood, carving, spears
Ceriops tagal	*Nhancandale, Mucandala*	22.7	Construction *barrotes*
Xylocarpus granatum	*Inrubo, Mrubo*	13.1	Oars and spears
Heritiera littoralis	*Ncolongo*	12.0	Canoe construction
Sonneratia alba	*Mepia*	8.6	Firewood, construction *barrotes*
Bruguiera gymnorrhiza	*Mfinse, Muconha, Panjeno*	5.5	Construction posts, firewood
Rhizophora mucronata	*Nhantezera*	4.2	Construction posts
Thespesia populnea	*Muandembe, Mulola, Murrosi*	1.6	Cords when young
Laguncularia racemosa	*Mpiripito*	0.3	Firewood, carving, posts

Villagers are relatively selective in their use of mangroves, with *Avicennia, Ceriops* and *Xylocarpus* being harvest most. *Ceriops* was stated as being the most preferred species (Fig. 4.6.5).

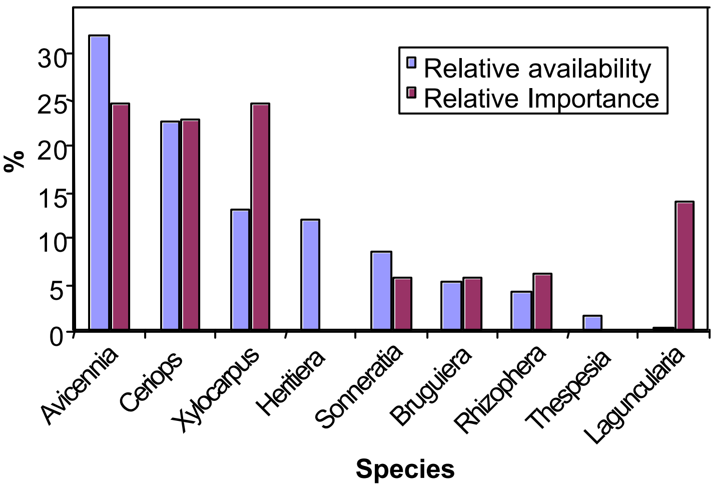


Figure 4.6.5. The relative quantities of different mangroves harvested from the Delta (from focus group discussions) vs their relative abundance.

In the outer Delta, 77% of households claimed to harvest mangrove wood. Households in the inner Delta do not have access to mangroves. User households harvest 41 poles on average per year, and 12% of households sell part of their harvest. *Ceriops* sells for Mt2000 per pole, *Rhizophera* for Mt1500, and the remaining species are sold for Mt1000 per pole. In addition, firewood bundles (from branches) sell for Mt1000 per bundle (focus group data). Based on the household survey, a total of 1.36 million poles and bundles of firewood harvested annually in the Delta. The value of this harvest is summarised in Table 4.6.13. In all, 91% of harvesting is done by men, 4% by women, and the remainder by children.

Table 4.6.13. The value of mangrove wood harvesting in the Delta

	Meticais Financial	Economic	US $ Financial	Economic
Average per user household:				
Gross value	67,650	81,180	5.41	6.49
Net value	56,999	56,724	4.56	4.54
Gross cash income	3,564		0.29	
Gross home value	64,086		5.13	
Gross returns to labour (per day)	9,188		0.74	
For whole wetland area:				
Gross value	1,597,343,343	1,916,812,012	127,787	153,345
Net value	1,345,848,765	1,339,362,878	107,668	107,149
Gross cash income	84,152,722		6,732	
Gross home value	1,513,190,621		121,055	

Sustainability

Members of a focus group on mangroves on Chinde Island described a noticeable decrease in abundance of mangroves over the past four decades (Fig. 4.6.6). However, they maintained that mangroves were still plentiful, and that this had not had a significant effect on them. They do not expect any problems of scarcity in the future. They also did not believe there would be any effect on the fisheries.

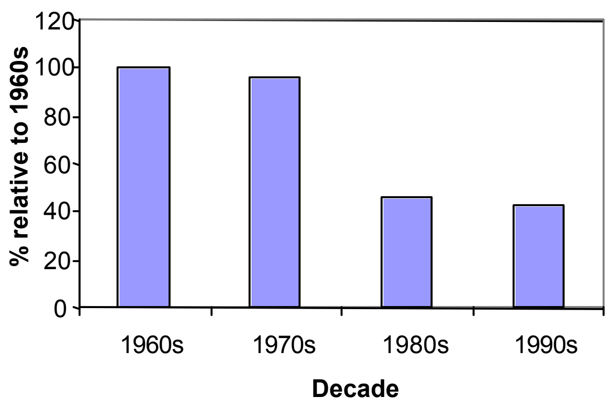


Figure 4.6.6. Perceived change in the availability of mangroves by a focus group in Tanque, Chinde Island.

Mangroves in the Delta area are undergoing 4 types of changes (Sweco 1982):

Successions - a natural process, countered by erosion. It has been suggested that the Delta may be submerging, leading to coastal die back (Davies 1979) and inland movement of mangroves, but this is unsubstantiated. It is thought that the trapping of sediments by the Kariba and Cahorra Bassa dams may have induced desiccation and erosion in the Delta.

Selective felling of trees for building materials. This wood is in demand locally because it is resistant to termites. It also produces good charcoal. According to DNFFB (1998), removal of mangroves for construction poles and firewood are the main form of mangrove exploitation.

Clear felling for land for cultivation. Areas of mangroves are converted for rice cultivation and salt production (DNFFB 1998). Large areas have already been transformed into cultivated land, and abandoned farmlands become bushland thickets (Sweco 1982).
Changes in habitat due to erosion and sedimentation. It is impossible to determine whether the mangrove area is in equilibrium *vis a vis* the eroding and depositing forces. The dynamic changes are difficult to assess.

Between 1972 and 1990, the mangrove areas in Zambézia and Sofala have been depleted by 4.9% and 2.4% respectively (Saket & Vasco Matusse 1994). The mangroves immediately around Chinde are in an advanced state of degradation due to overexploitation (population pressure) and coastal erosion (DNFFB 1998). According to Saket & Vasco Matusse (1994), mangrove use should be halted in overexploited areas to allow recovery, and clearing of mangroves for rice or salt production should be stopped completely. Exploitation in the remaining areas should be regulated to prevent degradation and guarantee sustainable production. The mangroves should be continuously monitored (Saket & Vasco Matusse 1994).

One of the reasons for the conversion of mangroves is the lack of recognition of the true economic value of their conservation compared to the benefits of development (Ruitenbeek 1994) or agriculture. Benefits of conservation not only stem from traditional non-commercial uses, selective mangrove logging, but possibly more importantly from the indirect function of the mangroves in maintaining the commercial use of fish that spawn in mangroves. This value is discussed in Chapter 5.

4.6.5.2 Palms

In the inner Delta, households mainly make use of *Borassus aethiopum* palms (*Medicua*) and Hyphaene coriacea palms (*Micheu*). At the coast, *Phoenix reclinata* (*Mchindu*) was also named as an important palm species, as was the exotic coconut palm (*Coceira*).

The *Borassus* palm communities form an integral part of the wetland, covering more than 65 000 ha (Schwarz, Sofala Investments, pers. comm.). The *Borassus* palm dominates throughout much of this area, although *Hyphaene* and *Phoenix* are also common. The area under this vegetation type described by DNFFB (1998) is a mosaic of grasslands, woodlands and agricultural areas. The palm savanna can be divided into two zones in which the densities of palms and fronds differ significantly (Table 4.6.14).

Table 4.6.14. Densities of *Borassus aethiopum* (DNFFB 1998)

Zone	Area (ha)	Trees per ha	Fronds per ha
Safrique/Chueza	18000	80	1168
Gotchi/Nensa	15600	17	260
Overall mean		51	746

The trunks of *Borassus* palms are cut into planks, yielding about 12 to 24 planks per tree, while the other species are more often used as poles (focus group data). Palm fronds are used as roof coverings (Table 4.6.15), as well as for making mats, hats and baskets (see below). About 50-100 fronds are used to cover one house (DNFFB 1998).

Table 4.6.15. Quantities of materials that are used to construct different types of houses in Safrique (Barbosa *et al*. 1997d).

Material		Type of house		
Name	Local name	*Gongue*	*Nsucure*	*Ramada*
Borassus palm	*Midicua*	46 mats	40 mats	20 bundles
Hyphaene palm	*Micheu*	2 bundles	4 bundles	2 bundles
Poles	*Canico*	6 bundles	8 bundles	4 bundles
Grass	*Capim*	30 bundles	40 bundles	25 bundles
Clay	*Barro*	+	+	-

The fruit is made into a sweet edible pulp and the sap is used to make traditional palm wine as well as in the construction of canoes (DNFFB 1998). *Hyphaene* sap is also used to make wine (*sura*). On Chinde island, villagers in a focus group on palms stated that the coconut palm was superior in most respects. The wood, fronds and palm wine produced from these trees was considered better than those provided by any of the indigenous species.

Table 4.6.16. Value of palm resources used in the Delta

	Meticais		US $	
	Financial	Economic	Financial	Econonmic
Average per user household: palm wood				
Gross value	294,000	352,800	23.52	28.22
Net value	283,349	309,430	22.67	24.75
Gross cash income	22,260		1.78	
Gross home value	271,740		21.74	
Gross returns to labour (per day)	16,848		1.35	
Average per user household: palm sap				
Gross value	644,000	644,000	51.52	51.52
Net value	643,857	636,615	51.51	50.93
Gross cash income	54,000		4.32	
Gross home value	590,000		47.20	
Gross returns to labour (per day)	166,731		13.34	
Average per user household: palm leaves				
Gross value	17,000	17,000	1.36	1.36
Net value	16,857	9,826	1.35	0.79
Gross cash income	675		0.05	
Gross home value	16,325		1.31	
Gross returns to labour (per day)	4,533		0.36	
For whole wetland area: all palm resources				
Gross value	7,264,484,658	8,274,214,294	581,159	661,937
Net value	7,075,884,624	7,242,946,306	566,071	579,436
Gross cash income	539,979,049		43,198	
Gross home value	6,724,505,609		537,960	

In the household survey, 28% of households claimed to harvest palm wood: 28% harvest, with an average harvest by a user household of 84 planks or poles per year. Of these, 12% sell part of their harvest, at a mean price of Mt3500. Thus a total of 1.84 million planks, mostly *Borassus*, are cut per year in the Delta. With each tree yielding 12-24 planks (focus groups data), this means a harvest of approximately 77 000 - 153 000 palms per year. About 4% of households claimed to collect palm sap, with a mean user household harvest of 129 litres per year. Of these, 9% sell palm wine, at a price of approximately Mt5000/litre. A total of 61% of households harvest palm leaves, on average 9 bundles a year. Of these 9% sell part of their harvest, at a price of Mt2500 per bundle on average. The values generated from palm resources are summarised in Table 4.6.16. 91% of harvesting is done by men, 4% by women, and the remainder by children.

Sustainability

There is no regulation over the use of palms, except that villagers do not venture beyond the boundaries of their own lands to harvest these resources. Villagers claim that the availability of palms has decreased over the past two decades (Fig. 4.6.7). In Safrique it was stated that part of the reason for the recent decline was that Sena Sugar had used a lot of palms for construction. However, villagers did not believe that there was a problem with the availability of palms.

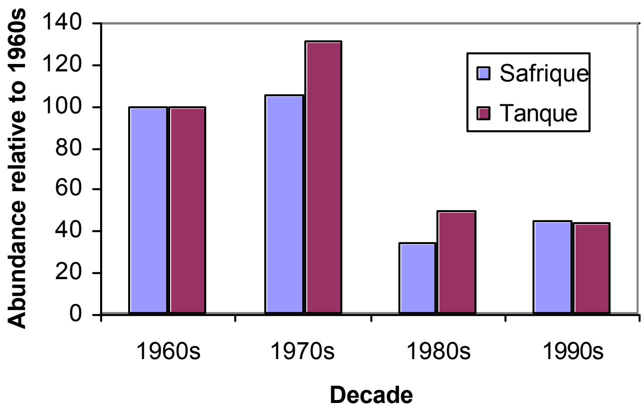


Figure 4.6.7. Delta focus group perceptions of change in abundance of palms over the past four decades.

In Gotchi, 15 *Borassus* palms are cut per ha on average (DNFFB 1998). According to DNFFB (1998), this corresponds to a harvest of 29% of the resource, based on the overall average density in that area (Table 4.6.14). However, the harvest amounts to 88% of the resource in the specific area in which it is harvested! DNFFB recommends exploiting up to 15% of the *Borassus* palms. Although the size distribution of *Borassus* palms is given in DNFFB (1998), no harvest models have been developed, and it is unknown whether the existing or recommended levels of use are sustainable.

Value added through processing

Palm leaves are used for making mats, hats, and baskets. About 11% of households weave mats, 3 per year on average, and 33% of producer households sell some of their products for an average of Mt 18 300. About 4% of households make hats, at an average rate of 5 per year, and 27% of these households sell hats, at an average price of Mt 3500. 21% of households make baskets, at a rate of 8 per year on average, and 21% of these households sell baskets, at Mt 8000 on average. The value added to palm leaves by these activities is summarised in Table 4.6.17.

Table 4.6.17. The value added to palm leaves in the Delta.

	Meticais		US $	
	Financial	Economic	Financial	Econonmic
Average per producer household: palm mats				
Gross value	62,332	74,799	4.99	5.98
Net value	34,832	5,861	2.79	0.47
Gross cash income	28,049		2.24	
Gross home value	34,283		2.74	
Gross returns to labour (per day)	2,820		0.23	
Average per producer household: palm hats				
Gross value	15,750	18,900	1.26	1.51
Net value	9,625	-8,319	0.77	-0.67
Gross cash income	7,371		0.59	
Gross home value	8,379		0.67	
Gross returns to labour (per day)	1,400		0.11	
Average per producer household: baskets				
Gross value	77,000	77,000	6.16	6.16
Net value	57,450	39,042	4.60	3.12
Gross cash income	20,370		1.63	
Gross home value	56,630		4.53	
Gross returns to labour (per day)	7,843		0.63	
For whole wetland area: all palm products				
Gross value	1,450,844,968	1,542,674,211	116,068	123,414
Net value	998,508,905	521,965,628	79,881	41,757
Gross cash income	469,660,672		37,573	
Gross home value	981,184,296		78,495	

4.6.5.3 Reeds & papyrus

Reeds are used in house construction and papyrus is used for making sleeping mats and doors. A total of 86% of households harvest reeds and papyrus in the Delta, with more households being engaged in this activity in the inner Delta (98%) than the outer Delta (73%). On average, households collect 11.4 bundles per year, with similar harvests being recorded in both regions. Middle ranking households tend to harvest more reeds than poorer households, but there was insufficient data on rich households to make a comparison (Fig. 4.6.8). About 9% of users sell part of their harvest at an average price of Mt2250 per bundle (range Mt1500 - 5400). The value of this activity is summarised in Table 4.6.18. Only men cut reeds and papyrus.

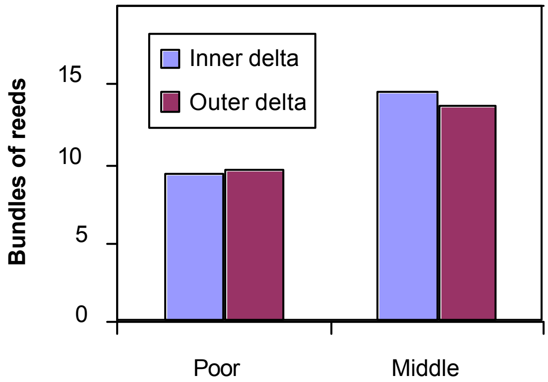


Figure 4.6.8. Differences in reed and papyrus harvests for poor and middle ranking households in the inner and outer Delta (household survey data).

Table 4.6.18. Value of reed and papyrus harvesting in the Delta.

	Meticais Financial	Economic	US $ Financial	Econonmic
Average per user household:				
Gross value	25,650	25,650	2.05	2.05
Net value	15,833	10,395	1.27	0.83
Gross cash income	2,957		0.24	
Gross home value	22,694		1.82	
Gross returns to labour (per day)	8,845		0.71	
For whole wetland area:				
Gross value	1,352,868,443	1,352,868,443	108,229	108,229
Net value	835,062,117	548,269,830	66,805	43,862
Gross cash income	155,935,889		12,475	
Gross home value	1,196,932,554		95,755	

Value added through processing

About 27% of Delta households are involved in the production of papyrus sleeping mats, and these households make 48 mats per year on average. Most (83%) producer households sell mats, at an average of Mt 7540 per mat. The value of mat making is given in Table 4.6.19.

Table 4.6.19. Value added by making mats from papyrus in the Delta.

	Meticais Financial	Economic	US $ Financial	Econonmic
Average per producer household:				
Gross value	361,968	361,968	28.96	28.96
Net value	135,718	89,593	10.86	7.17
Gross cash income	269,764		21.58	
Gross home value	92,204		7.38	
Gross returns to labour (per day)	14,714		1.18	
For whole wetland area:				
Gross value	5,993,819,884	5,993,819,884	479,506	479,506
Net value	2,247,351,277	1,483,568,451	179,788	118,685
Gross cash income	4,467,019,140		357,362	
Gross home value	1,526,800,744		122,144	

4.6.5.4 Grass

Several types of grasses are harvested from the floodplain. *Sanze* and *Nhacossongole* are used for house construction and thatch. *Pinda* is used for toilet construction and chicken hatches. *Tezi* and *Jogo* are used for thatch. The seasonality of grass collection is the same as for reeds and papyrus. A total of 81% of households harvest grasses from the floodplain, at an average rate of 36 bundles per year, with more households in the inner Delta (93%) being engaged in this activity than in the outer Delta (68%). Poorer households tend to harvest less grass than richer households (Fig. 4.6.9).

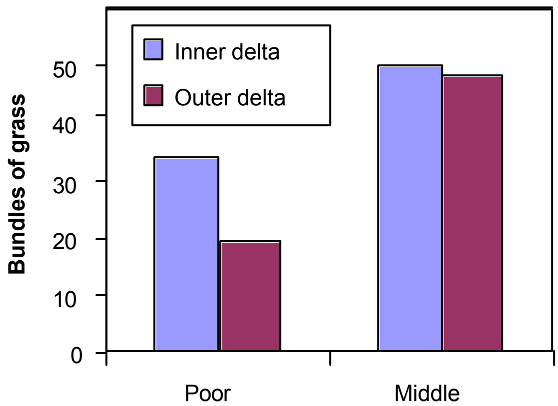


Figure 4.6.9. Differences in floodplain grass harvests for poor and middle ranking households in the inner and outer Delta (household survey data).

About 10% of user households sell part of their harvest, at about Mt2500 per bundle. The value of grass harvesting is summarised in Table 4.6.20. Only men cut grass.

Table 4.6.20. Value of grass harvesting in the Delta.

	Meticais Financial	Economic	US $ Financial	Econonmic
Average per user household:				
Gross value	91,000	109,200	7.28	8.74
Net value	90,715	93,235	7.26	7.46
Gross cash income	7,125		0.57	
Gross home value	83,875		6.71	
Gross returns to labour (per day)	10,882		0.87	
For whole wetland area:				
Gross value	4,520,600,795	5,424,720,954	361,648	433,978
Net value	4,506,446,812	4,631,648,204	360,516	370,532
Gross cash income	353,948,139		28,316	
Gross home value	4,166,652,656		333,332	

4.6.5.5 Food plants

A number of wild wetland plants are harvested for food and medicinal purposes in the Delta. Local names of these plants are given in Table 4.6.21, but it was not possible to identify the scientific names of these plants.

Table 4.6.21. Wetland plants used for food and medicine in the Delta (focus group data).

Plant species: Local name	Description	Availability	Safrique	Tanque
Minhanhe	roots	All year	y	y
Nzsanguzi			y	
Madikwa			y	
Missalemwa			y	
Pincha			y	
Ulanga			y	
Nzulu			y	
Magulango			y	
Nhica			y	
Kundi			y	
Marengo	fruit of *Strychnos cocculoides*	Sep		y
Matiele	fruit	March		y
Ngulutomo	fruit	Until Jan		y
Nenufar	water lily			y
Tembe	bulb under water			y
Mbambaza	mesuco tipo	Sep		y
Elinde	type of potato	June		y
Ntangalume	roots	June		y
Medicinal plants;				
Minimine				y
Nhapambano				y
Tembe				y
Nungo				y
Nhapeapeia				y

Previous studies have shown that, although agriculture plays a dominant role, villagers claim to depend to some extent on natural resources for food (Table 4.6.22). However, perceptions of the relative importance and especially of relative availability of different types of natural resources differ from village to village (Table 4.6.23). The village studies include comprehensive lists of the plant and animal species used, and their relative importance and availability. Livestock, although predominantly small stock, are rated relatively highly as a source of food.

Table 4.6.22. Perceived relative importance of different sources of food for inhabitants of Caoxe (Barbosa *et al.* 1997b)

Source	Points	Source	Points
Agriculture	9	Forest products	5
Water	7	Wild animals	5
Livestock	6	Shops	3
Fruit	5	Offerings	1

Table 4.6.23. Perceptions of importance and availability of resources in Caoxe and Safrique (Barbosa *et al.* 1997b).

Resource	Relative importance		Availability	
	Caoxe	Safrique	Caoxe	Safrique
Earth	9	10	9	Scarce
Water	6	10	1	Abundant
Seed	5	-	3	-
Plants	4	5.5	7	Scarce
Animals	1*	1#	5	Scarce
Birds	-	1	-	-
Fish	-	2	-	Abundant

* Fish and birds were considered relatively abundant, but terrestrial mammals scarce.
# 'Animals' = other than birds and fish

Women in focus groups claimed that they harvest wild plants throughout the year, but particularly during the period between November and March, when there is a shortage of crops. The patterns they reported differed to an extent between the inland and coastal villages (Fig. 4.6.10).

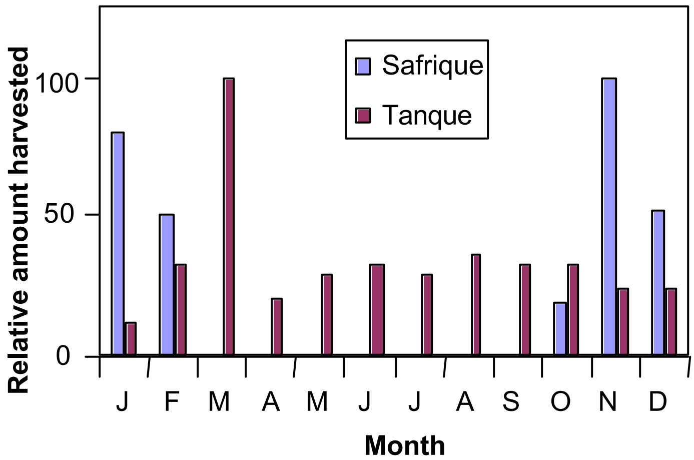


Figure 4.6.10. Relative amounts of wild foods harvested in different months of the year, according to focus groups of women collectors in Safrique (inner Delta) and Tanque (outer Delta).

About 42% of households claimed that they collect wild food plants, with more households harvesting these foods in the outer Delta (52%) than the inner Delta (33%). However, harvests in the inner Delta are higher than in the outer Delta (87 vs 26kg), and user households collect about 49kg per year on average. Although users claimed they are worth about Mt2500 per kg, no one actually sells these plants. The value of the harvest is summarised in Table 4.6.24. According to the household survey data, food plant collection is done by everyone, with men collecting 66%, women 28% and children 6%. However, the role of women may be underestimated, as most of the survey respondents were men.

Table 4.6.24. Value of wild food plants collected in the Delta.

	Meticais Financial	Economic	US $ Financial	Econonmic
Average per user household:				
Gross value (= gross home value)	122,500	122,500	9.80	9.80
Net value	121,881	116,467	9.75	9.32
Gross returns to labour (per day)	42,424	42,424	3.39	3.39
For whole wetland area:				
Gross value	3,155,405,113	3,155,405,113	252,432	252,432
Net value	3,139,467,097	3,000,009,461	251,157	240,001

In Safrique, women noted that the abundance of wild food plants had declined within the last five years (Fig. 4.6.11) as well as over the last four decades (Fig. 4.6.12). In Tanque, however, they claimed that these resources were previously more difficult to find, as many people had taken refuge on Chinde Island during the war, and were responsible for depleting the local resource base.

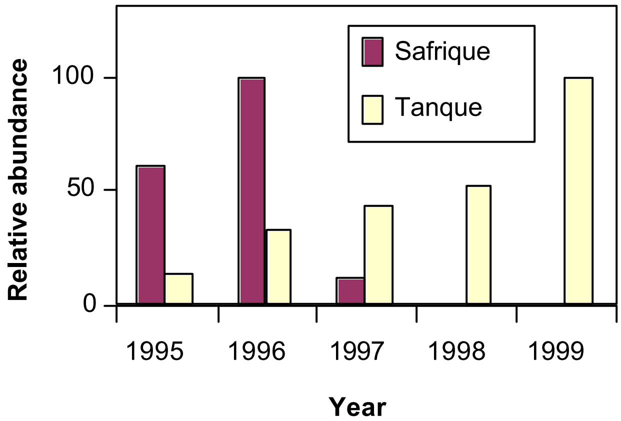


Figure 4.6.11. Perceptions of variability in abundance of wild foods over the last five years of villagers in Safrique (inner Delta) and Tanque (coast). (focus group data).

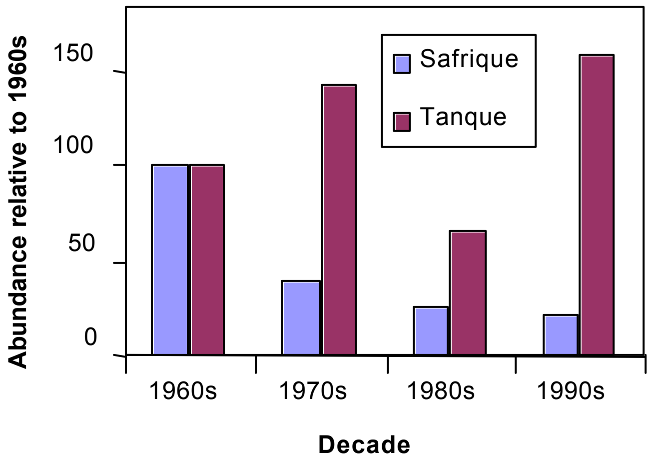


Figure 4.6.12. Perceptions of trends in availability of wild food plants over the past four decades of women in Safrique and Tanque (focus group data).

4.6.6 Clay

Households in the Delta were not asked about the collection of clay *per se*, but 4% of household claimed to make clay pots, with an average of 7 pots made per year. Of these, a quarter of households sell pots for income, at roughly Mt3500 per pot. The value of pottery is summarised in Table 4.6.25. Clay was not priced as an input, thus this is the total value of clay used in pot production. The value of clay is higher, as it is used for other purposes, such as in house construction.

Table 4.6.25. Value of clay pot production

	Meticais		US $	
	Financial	Economic	Financial	Econonmic
Average per producer household:				
Gross value	24,500	24,500	1.96	1.96
Net value	24,500	20,070	1.96	1.61
Gross cash income	5,250		0.42	
Gross home value	19,250		1.54	
Gross returns to labour (per day)	10,370		0.83	
For whole wetland area:				
Gross value	60,102,955	60,102,955	4,808	4,808
Net value	60,102,955	49,236,126	4,808	3,939
Gross cash income	12,879,205		1,030	
Gross home value	47,223,750		3,778	

4.6.7 Tourism

The Delta includes part of one of the biological hotspots of Moçambique - the Gorongosa-Marromeu Complex (Hatton & Munguambe 1997). However, while there is some hunting-related tourism in the area, non-consumptive tourism is almost non-existent in the Delta at present. This is due to lack of infrastructure, difficulty of access, threat of malaria and the perceived (and sometimes real) threat of landmines. Potential value, and the options for involvement of local communities, should be investigated.

4.6.8 Overall use value and local perceptions

According to this study, households perceive crops to be by far their most important source of income (including non-cash income). Fish and other wetland resources were perceived to be of similar value, and together make up almost the same value as generated by crops. Upland resources are relatively insignificant, and cash income from jobs is small (Fig. 4.6.13).

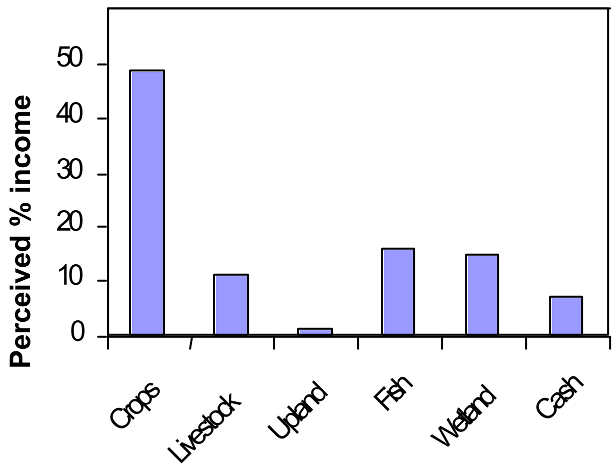


Figure 4.6.13. Mean perceptions of relative income (including non-cash income) from different resources in the Delta (household survey data).

Values accruing to rural households in the Delta from the wetland are summarised in Table 4.6.26. Crops account for the greatest value, with fisheries generating almost the same value as crops. Other resources each contribute relatively little to the average household per year, but added up, they account for a substantial value of US$2.6 million to households annually. Fisheries contribute 75% of cash income, and other natural wetland resources account for 13%. In all the wetland is estimated to be worth approximately US$22 million annually to the economy in terms of its gross use value. Its net economic value, US$15 million, is still large.

Thus values obtained in this study were spread somewhat differently among different resources than the perceptions of this distribution (Fig. 4.6.14). Crops are worth less than generally perceived, and fish and other wetland resources are worth more. We did not include an estimate of the value of livestock production, however, so the relative values of fish and wetland resources are probably fairly close to expected. The high perceived value of crops is probably linked to their food security value, as crops are the most important resource for survival.

Table 4.6.26. Summary of current consumptive wetland use values in the Delta

DELTA	Crops	Fish & shell-fish	Ani-mals	Mang-roves	Palms	Reeds & pap-yrus	Grass	Food plants	Clay	TOTAL
Average wetland hh (US$/y)										
Gross financial value	121.21	99.81	0.44	2.08	11.37	9.58	5.90	4.12	0.08	255
Net financial value	121.03	95.67	0.20	1.76	10.53	4.02	5.88	4.10	0.08	243
Gross cash income	7.13	45.34	0.16	0.11	1.32	6.03	0.46	-	0.02	61
Gross home value	114.08	54.47	0.28	1.97	10.05	3.55	5.44	4.12	0.06	194
ZBWCRUP Project area (US$ '000s/y)										
Gross economic value	5,475	5,403	20	113	578	432	319	186	4	12,526
Net economic value	2,787	4,746	3	79	457	120	273	177	3	8,641
Gross financial value	5,468	4,503	20	94	513	432	266	186	4	11,482
Net financial value	5,460	4,316	9	79	475	181	265	185	4	10,970
Gross cash income	322	2,045	7	5	59	272	21	-	1	2,731
Gross home value	5,146	2,457	13	89	453	160	245	186	3	8,750
Total wetland (US$ '000s/y)										
Gross economic value	7,443	7,345	27	153	785	588	434	252	5	17,028
Net economic value	3,789	6,453	5	107	621	163	371	240	4	11,747
Gross financial value	7,434	6,121	27	128	697	588	362	252	5	15,609
Net financial value	7,423	5,867	12	108	646	247	361	251	5	14,914
Cash income	437	2,780	10	7	81	370	28	-	1	3,713
Gross subsistence value	6,996	3,341	17	121	616	218	333	252	4	11,896

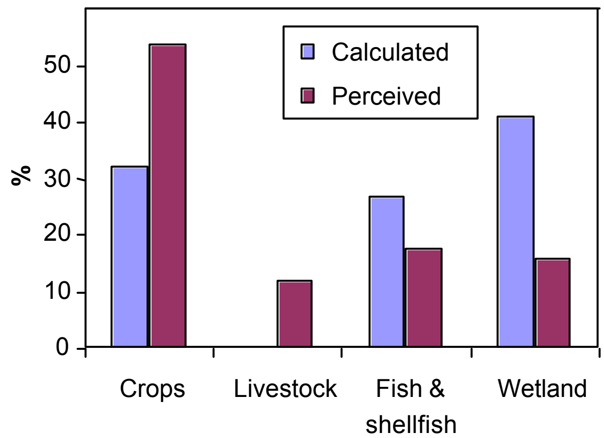


Figure 4.6.14. Relative measured value of crops, livestock, fish and wetland resources for the Delta obtained in this study, vs their relative perceived value (household survey data). Note that calculated value for livestock does not take small stock into account.

4.7 COMPARATIVE OVERVIEW

This section summarises the main findings on direct use values and the four ZBWCRUP study areas are compared with one another and with findings reported in other studies. Both financial and economic values are important to consider in the context of management of resources in the Zambezi basin wetlands. The financial returns are those that govern household and investor behaviour, and an understanding of these values is important if incentives measures are to be put in place to encourage the sustainable use of resources. The economic values illustrate the value of the wetland resources to the national economy, and also help govern national policy regarding the conservation and use of wetlands in the national interest.

According to our estimates, the four study areas differ markedly in size and population density (Table 4.7.1). Rural population density of the Lower Shire area (162/km^2) is an order of magnitude greater than in the other sites, where densities range between 10 and 34 people per km^2.

Table 4.7.1. Size and main characteristics of the four study sites

	Barotse	Chobe-Caprivi	Lower Shire	Delta
Study area (km^2)	6600	3040	2430	17 890
Wetland area within study area	550 000	220 000	162 000	1 275 000
Overall rural pop density (n/km^2)	33.9	9.9	162.4	19.1

4.7.1 Cattle and crops

Cattle densities are relatively similar across three of the study areas (Table 4.7.2), being highest in the Barotse wetland, but cattle are virtually non-existent in the Delta. Subsistence crops generally make up a fairly small proportion of wetland area. Crops make up a very high proportion of wetland area in the Lower Shire, where the ratio of cattle to people is low. The Delta, where cattle are virtually absent, has a relatively high % cover of crops compared to the remaining sites. The area under crops in Chobe-Caprivi can be attributed to the large average field size there. In Barotse, a relatively small area of the wetland is estimated to be under crops, largely due to the small average area of fields grown by households.

Table 4.7.2. General statistics on cattle and crops in the four study areas (household survey data).

	Barotse	Chobe-Caprivi	Lower Shire	Delta
Peak cattle density (n/km^2 wetland)	79.1	39.3	64.5	<0.2*
% study area under subsistence crops	3.6%	9.1%	52.0%	8.6%
Overall % study area under crops	3.6%	9.1%	58.8%	10.5%

* Sena Sugar holds about 2000 head of cattle.

Financial and economic values of wetland agriculture are given for each of the four study areas in Tables 4.7.3 and 4.7.4. This study shows that traditional agriculture - livestock and/or cropping - plays a dominant role in the household economy in all four of the wetland areas, although cattle do not feature in the Delta.

The net financial (cash + consumption) income per household from livestock production in three wetlands ranged from US$31 per household in Lower Shire, where numbers of cattle per household are relatively low, to US$422 per household in Caprivi (Table 4.7.3). Financial returns per ha of floodplain grassland range from US$16 in Barotse to US$97/ha in Caprivi. The offtake of cattle for sale or subsistence use was similar in all three areas - 6.6% in Barotse, 5.6% in Caprivi, and 6.3% in Lower Shire. The financial benefits of cattle are linked to the price of stock in the four wetlands. Stock prices were highest (US$117/LSU) in Caprivi, as compared with US$76/LSU and US$50/LSU in Barotse and Lower Shire, respectively. Economic benefits of cattle are generally also high in the three wetlands, being higher than the financial returns in two of the sites, but slightly lower in Caprivi (Table 4.7.3).

Table 4.7.3. Annual net financial and economic values (US$ 1999) and returns obtained from livestock within the four study sites.

	Barotse	Chobe-Caprivi	Lower Shire	Delta
Net financial value	3 323 000 (120/hh)	1 944 000 (422/hh)	1 770 000 (31/hh)	-
Net economic value	3 908 000	1 831 000	2 006 000	-
Net financial returns to land (ha floodplain grassland)	15.7	97.2	54.6	-
Net economic returns to land (ha floodplain grassland)	17.8	91.5	61.9	-

Crops contribute a net financial value of between US$89 per household in Barotse to US$295 in the Lower Shire (Table 4.7.4). Cultivated fields in the Lower Shire yield the highest net financial returns to households of US$203/ha, with slightly lower returns in the Barotse wetlands. The net financial returns to land are low in the Delta, and particularly low in the Caprivi. Crop prices obtained by subsistence farmers were very similar across all four study areas, except for maize. Maize is the most important crop in all study areas except the Delta, where rice is more important. In the Caprivi and Delta, maize prices (US$.0,09/kg) were half that in Barotse and Lower Shire (US$0.18/kg). This would have a major influence on the financial returns in these sites. The differences in crop incomes per hectare are mainly due to differences in the yields reported for the four areas. Maize yields were over 600kg per ha in three sites, but under 370 kg/ha in Caprivi. Millet yields were over 620kg/ha in Barotse and Shire, but under 430 kg in Caprivi and the Delta. Similarly, rice and sweet potato yields were over 1 ton per ha in Barotse and Shire, but under 700kg/ha in the Delta.

The estimated economic value of subsistence agricultural crop production is considerably lower than the financial value at all sites, mainly because of the influence of labour costs, and also because the world price of maize is only US$0.10/kg. It appears that the production of crops in Barotseland and Caprivi, while financially viable to households, is not in the national interest, carrying a substantial negative cost (Table 4.7.4). It is quite probable, however, that the shadow price of labour is lower than the estimated 35% of minimum wage, particularly in these rural areas which are far from any major centres.

Table 4.7.4. Annual net financial and economic values (US$ 1999) and returns obtained from subsistence agricultural cultivation within the four study sites.

	Barotse	Chobe-Caprivi	Lower Shire	Delta
Net financial value	2 447 000 (89/hh)	981 000 (212/hh)	17 100 000 (295/hh)	9 475 000 (121/hh)
Net economic value	- 75 000	-3 938 000	13 270 000	4 837 000
Net financial returns to land (ha cultivated area)	122.3	49.0	203.0	67.9
Net economic returns to land (ha cultivated area)	-3.77	-196.9	157.5	34.7

Nevertheless, the value of these crops in terms of culture and food security cannot be ignored. Food security, in an area where cash income is particularly low, is the underlying reason why many households retain a large percentage of their annual crop for subsistence. Growing crops also has other benefits. In Caprivi, under customary law, the 'right to avail', or right to make use of the natural resources available to the community, requires maintaining some sort of presence on communal lands (Ashley & LaFranchi 1997). Working fields provides evidence to the Bukalo *kuta* that the right to avail has been discharged, hence crops have additional social value to the household of maintaining access to communal lands and the resources they contain.

Irrigation and commercial agricultural schemes have been established in all four of the wetland areas, mainly for the production of sugar and rice for commercial and export purposes. It is difficult to obtain detailed information for most of these schemes, but production in the Lower Shire suggests that they yield very high financial gross returns in comparison to subsistence agriculture.

Detailed economic analyses of large scale irrigation and commercial agricultural schemes, in the countries involved, are difficult to access if they exist at all. In northern Namibia and Botswana, some studies have looked at the financial and economic value of large irrigated commercial schemes. Low (1996) carried out a detailed analysis of a large scale commercial irrigation scheme in northern Namibia (the Etunda scheme) and found it to be economically non-viable, and to require financial subsidies. Financial analyses of other possibilities for large scale commercial agriculture in northen Namibia (e.g. Loxton, Venn & Associates & Plan Medewerkers 1995) have shown them to require subsidisation for financial viability.

Edwards *et al*. (1989) reviewed evidence for financial and economic viability of large-scale commercial irrigation and rainfed agricultural development in Botswana. They found a rice scheme in the northern Okavango delta to be financially profitable but economically non-viable. Similarly, large scale irrigation development in the Okavango delta for production of relatively high value fruit and vegetables could not be justified on economic grounds. Economic analysis of irrigation development for small-holders in the Chobe Enclave area of northern Botswana, adjacent to the Chobe Caprivi wetlands in Namibia and serving local markets, found it to be economically unsound, although it was financially attractive for farmers. Another project examined was the Pandamatenga project for large-scale, rainfed, sorghum production in northern Botswana. This was found to require subsisdation for financial profitability and was also economically non-viable.

The economic inefficiency of the projects described above in Botswana and Namibia, was in all cases due to the high transport costs involved. The only potential irrigation developments in Botswana found to be economically viable were in the south eastern Limpopo basin, within a few hundred kms of large export markets in South Africa, and close to rail heads. Even here, viability was restricted to high value crops such as vegetables and citrus crops, and field crops were excluded.

The evidence above suggests that, in the wetlands of this study, none of the proposed large-scale commercial agricultural developments planned for the Barotse Floodplain in Zambia and Chobe Caprivi Wetlands in Namibia will add positively to national economies. Both are situated far too far from markets and sources of inputs. The existing and planned schemes of the Lower Shire Wetlands in Malawi and the Zambezi Delta in Moçambique are only ever likely to show economic viability if major infrastructure developments in Moçambique are effected. This will mean redevelopment of the railway between Malawi and Nacala, as well as the port at Nacala, and a port at Chinde. In the absence of more substantial evidence we have not included economic values for large-scale, commercial agricultural developments in this study. Although they may generate very high values per hectare, these values are unlikely to be positive economically.

Although the values reported in this study are from agriculture within the bounds and edges of the wetlands, not all agricultural production in the study areas is within wetland habitats *per se*. While much of the maize production and all rice and sugar production takes place within the wetlands in all of the study areas, many of the remaining crops listed in the different areas are grown in upland habitats. For crops grown within the wetlands, the value attributable to the wetland is that of increased input into agricultural production over and above the production that would be achieved from agricultural lands in an upland habitat, *ceteris paribus*. The latter value is, strictly speaking, an indirect use value of the wetland, because wetland resources (water and nutrient rich soils) are used as an input into production., rather than as a final good or service. However, we have included agricultural activities with all other household activities which utilise wetland resources, under use values, for ease of comparison and to understand household behaviour. It is important to appreciate that the overall value of wetland agriculture presented here represents the value of *conversion*, rather than conservation, of the wetlands.

4.7.2 Harvested natural resources

In general, the amounts of resources harvested per household were fairly similar across all four study areas, usually being within the same order of magnitude (Table 4.7.5). Fish catches appear to correspond to the ecological status of the wetlands. The highest fish catches were recorded in Barotse, which is the wetland considered to be in the most pristine state. Similarly, the Chobe-Caprivi wetlands are in a relatively healthy state. The lowest catches were recorded in the Lower Shire, where the wetlands have been severely impacted by hydrological changes, water hyacinth and human activity. The Delta has been severely impacted by hydrological changes, although it does not appear to have suffered nearly as much from the other types of anthropomorphic degradation found in the Lower Shire.

Table 4.7.5. Average harvests per household (including non-user housholds) of wetland resources common to all four study areas.

	Barotse	Chobe-Caprivi	Lower Shire	Delta
Fish (kg)	381.6	277.5	168.2	201.1*
Other animals (animals or kg)	0.62	36.7 kg	3.5	1.8
Palm leaves (bundles)	0.2	8.4	?	4.2
Reeds & papyrus (bundles)	16.7	36.9	15.7	9.8
Grass (bundles)	13.7	33.8	57.8	29.5
Food plants (kg)	?	32.1	62.8	20.6

* excludes crustaceans catch of 45.9kg

Harvest of animal resources was generally found to be low (Table 4.7.5), with people generally referring to small animals such as birds and rodents, but were reported to be fairly high in Caprivi, where game animals, although also severely depleted, are still replenished by the wetlands' connection with the Chobe National Park.

Plant resources were generally reported to be harvested in greater quantities in Caprivi than in the other sites (Table 4.7.5). Palm leaves are harvested in greater quantities in Caprivi than in Delta, which is contrary to expectation, as the supply is much greater in the latter wetland. Harvests are fairly low in Barotse, as expected, but may be underestimated because the design of this questionnaire was such that people named the most important resources they harvested, rather than being asked about every resource. Reeds and papyrus are harvested in somewhat lower quantities in the Delta than at the other sites, and this may be due to the fact that many dwellings are constructed of other materials, such as palm wood, thus reducing the demand for reeds as structural building material. Grass appears to be a particularly important resource in the Lower Shire, but this is possibly an artefact, as recent floods in the area may have temporarily increased the demand for thatching grass.

Insufficient data were gathered on the collection of food plants in Barotse to estimate the average harvest there, although it is known that these plants are utilised widely. Harvests of food plants are significant in the Lower Shire, but small in the Delta, despite the fact that in the Delta food plants are considered an important resource to tide over families during the famine period November to February. The harvest of these resources is particularly difficult for households to quantify, however.

Natural resources harvested from the wetlands, particularly fish, make a substantial contribution to household income (Table 4.7.6). Natural resources are also harvested from upland habitats within the study areas, but these were not included in the study.

Fisheries yield substantial income in all four wetlands, with the total contribution being related to wetland size. (Table 4.7.6). Indeed, the value per unit area of wetland, and of fish habitat in particular, is remarkably uniform across all sites (Tables 4.7.7 and 4.7.8). Income per household, however, is much lower in the Lower Shire than in the other sites, and is also relatively low in the Delta, compared with Caprivi and Barotse (Table 4.7.6). Wild animals generally yield almost negligible income per household, except in Caprivi.

Table 4.7.6. Annual net financial and economic values (US$ 1999) of natural resources harvested by wetland households.

	Barotse	Chobe-Caprivi	Lower Shire	Delta
FISH & CRUSTACEANS				
Net financial value	4 803 000	1 034 000	2 445 000	5 867 000
	(174/hh)	(224/hh)	(42/hh)	(96/hh)
Net economic value	4 258 000	694 000	1 730 000	6 453 000
WILD ANIMALS				
Net financial value	11 290	219 380	14 000	12 000
	(0.4/hh)	(48/hh)	(0.2/hh)	(0.2/hh)
Net economic value	10 230	215 720	10 000	4 600
MANGROVES				
Net financial value	-	-	-	108 000
				(2/hh)
Net economic value	-	-	-	107 000
PALMS				
Net financial value	7 410	12 930	5000	646 000
	(0.3/hh)	(3/hh)	(0.1/hh)	(11/hh)
Net economic value	3 260	5 040	2 000	621 000
REEDS & PAPYRUS				
Net financial value	296 000	399 000	284 000	247 000
	(11/hh)	(87/hh)	(11/hh)	(4/hh)
Net economic value	271 000	278 000	298 000	163 000
GRASS				
Net financial value	293 000	129 000	1 867 000	361 000
	(8/hh)	(28/hh)	(32/hh)	(6/hh)
Net economic value	221 000	130 000	2 169 000	371 000
FOOD PLANTS				
Net financial value	?	49 230	386 000	251 000
		(11/hh)	(7/hh)	(4/hh)
Net economic value	?	23 370	370 000	240 000
CLAY				
Net financial value	64 370		140 000	4800
	(2/hh)		(2/hh)	(0.1/hh)
Net economic value	51 760	?	224 000	3900
TOTAL NET FINANCIAL VALUE	5 404 000 (9.8/ha)	1 845 000 (8.4/ha)	5 140 000 (31.7/ha)	7 496 000 (7.5/ha)
TOTAL NET ECONOMIC VALUE	4 815 000 (8.8/ha)	1 446 000 (6.6/ha)	4 803 000 (29.7/ha)	7 962 000 (8.0/ha)

Plant resources also generally yield fairly small incomes per household, but added up, make a significant contribution to wetland value (Table 4.7.6). Reeds, sedges and grasses are harvested in all four areas, and palms and mangroves provide an additional and significant source of value in the Delta. These resources form the basis of house construction in all the areas, as well as being used for constructing fish traps, baskets, mats, etc.

The total financial net returns and economic net returns per wetland were strongly related to population density. Overall financial returns per ha was significantly positively related to number of people per km^2

($/ha = 5.2 + 0.16*people/km^2; $r^2 = 0.995$, $p < 0.01$, $n = 4$), as were economic returns per ha ($/ha = 4.6 + 0.15*people/km^2; $r^2 = 0.997$, $p < 0.01$, $n = 4$). This is to be expected, because the lifestyles of people in the different wetlands are relatively similar. Notice, however, that the slopes of these regressions are not unity. The average value per person decreases as the density of people increases. This is an important insight into the value of wetlands, as it is clear that value is determined largely by the number of users, and hence total amount of use, but that value per individual declines as population density increases. The above equations could probably be used to estimate the total value of all the Zambezi basin wetlands.

The overall returns of the each resource per unit area of wetland and per unit area of the habitats from which they are harvested are compared for all four wetlands in Tables 4.7.7 and 4.7.8. In general, these values, especially on a habitat level, are very similar across all wetlands, except that they are usually somewhat higher in the Lower Shire. Returns from grasses and food plants are much higher in the Lower Shire than in other sites, and returns from reeds and papyrus and wild animals are high in Caprivi. Palm savanna yields much higher returns in the Delta than in other wetlands. If all the uses were sustainable the maximum values would provide an estimate of the potential value that could be obtained from each wetland. However, the sustainability assumption cannot be applied here.

Table 4.7.7. Financial (Fin) and economic (Econ) returns to wetland area (US$ per ha) obtained from different resources within the four study areas.

	Barotse		Chobe-Caprivi		Lower Shire		Delta	
	Fin	Econ	Fin	Econ	Fin	Econ	Fin	Econ
Fish & crustaceans	8.7	7.7	4.7	3.2	15.1	10.7	4.6	5.1
Wild animals	0.02	0.02	1.0	0.98	0.08	0.06	0.01	<0.01
Mangroves	-	-					0.1	0.1
Palms	0.01	0.01	0.17	0.02	0.3	0.1	0.5	0.5
Reeds & Papyrus	0.5	0.5	1.8	1.7	1.8	1.8	0.2	0.1
Grass	0.4	0.4	0.6	0.6	11.5	13.4	0.3	0.3
Food plants	?	?	0.2	0.1	2.4	2.3	0.2	0.2
Clay	0.12	0.09	?	?	0.9	1.4	<0.01	<0.01
Tourism value	-	-	1.19	3.57	-	-	-	-

4.7.2.1 Sustainability of natural resource use

At all four sites rural wetland inhabitants were generally under the impression that the availability of natural resources had declined over the past few decades, with very few exceptions where villagers believed that there was no change. This indicates a potentially bleak outlook for the future if the reported trends are real and continue. The steepness of the declines cannot, however, be taken literally from the graphs presented in the preceding sections, as the methodology is only reliable as far as general trends go, but not in quantifying relative amounts. Thus only detailed biological studies, including long-term monitoring, would be able to determine the exact nature of these changes.

Table 4.7.8. Financial and economic returns to wetland habitats (US$ per ha) obtained from different resources within the four study areas.

	Barotse		Chobe-Caprivi		Lower Shire		Delta	
	Fin	Econ	Fin	Econ	Fin	Econ	Fin	Econ
Floodplain grassland								
Grass	1.0	1.0	0.6	0.6	57.6	67.0	1.7	0.7
Marsh and channel area								
Fish & crustaceans (including mangrove area)	15.1	13.4	16.8	11.3	19.4	13.7	8.4	9.2
Food plants	?	?	0.2	0.1	2.4	2.3	0.2	0.2
Mangroves								
Mangroves	-	-	-	-			0.6	0.6
Palm savanna								
Palms	0.7	0.3	3.4	1.2	1.5	0.5	10.1	9.7
Marsh								
Reeds & Papyrus	5.4	4.9	22.6	21.5	6.5	6.8	1.9	1.3
Whole wetland								
Wild animals	0.02	0.02	1	0.98	0.08	0.06	0.01	<0.01
Clay	0.12	0.09			0.9	1.4	<0.01	<0.01
Tourism	-	-	1.19	3.57	-	-	-	-

4.7.3 Gender responsibilities in resource use

Similar patterns were found across all the study areas regarding the gender divisions of labour in the household with respect to wetland resources. Cattle are generally the responsibility of men and boys, while cropping is a family affair, with both men and women taking part in the more physical aspects of field preparation, as well as tending and harvesting. According to the household surveys, men take the lead role in harvesting most wetland resources apart from papyrus, food plants and palm leaves in some wetlands. Hunting, fishing and palm or mangrove wood collection is almost the exclusive domain of men, although women fish to a very small extent. Women play a secondary, but significant, role in the collection of reeds and grasses. In the case of grass, women sometimes do the cutting, while the men transport the harvest home. While men were responsible for all palm leaf and sap collection in the Delta, this role was shared in other wetlands. Perhaps this is due in part to taller palms being harvested in the Delta. In focus group discussions in the Delta, women gave the impression that they harvested most of the food plants themselves. This was not borne out in the household survey, however, which suggested that men dominate this collection. Although men play a role in collecting food plants in other wetlands, women are by far the most common collectors of these resources.

Women generally play a more important role in adding value to wetland resources, except in the Lower Shire. Women are always responsible for making beer and clay pots, while men are always responsible for making hats, and hunting or fishing traps. Most of the latter are probably for home use, however, and are not for sale. Gender roles in mat-making differ from wetland to wetland. Palm mats are relatively complex woven mats, and are made exclusively by men in the Delta, where men are also responsible for making papyrus mats. Women make most papyrus and reed mats in Barotse and Chobe-Caprivi, but men take on this task in Lower Shire. Similarly, while men make baskets and brooms in Lower Shire, women take on this work in the other wetlands.

Table 4.7.9. Summary of the relative contributions of men, women and elderly or children in the harvest and production of resources.

	Barotse			Chobe-Caprivi			Lower Shire			Delta		
	M	F	E/C	M	F	E/C	M	F	E/C	M	F	E/C
Agriculture												
Cattle	X		X	X		X	X		X	X		X
Crops	X	X	X	X	X	X	X	X	X	X	X	X
Natural resource harvesting												
Fish	69	24	7	89	4	6				95	2	3
Crustaceans										92		8
Wild animals	100			100			100			100		
Reeds	100			69	31		67	24	9	98		2
Papyrus	47	50	3	81	19		67	24	9	98		2
Grass	50	50		78	22		74	26		98	1	1
Mangrove/palm wood										91	4	6
Palm leaves/sap	50	50		16	84					100		
Food plants				11	84	4	8	85	7	66	28	6
Clay	33	67										
Adding value to resources												
Beer		100			100			100			100	
Papyrus mats	13	87			100					100		
Reed mats	33	66					100					
Palm mats										100		
Bird/fish traps	100			100			100			100		
Baskets	6	94					100			21	79	
Brooms		100					100					
Hats	100						100			75	25	
Pots		100						100			100	

Overall, the harvest of resources is dominated by men, and value adding activities are dominated by women. Both are time-consuming activities. While harvesting is generally more physical, crafting activities can be done around the homestead whilst minding children. The central role of women in raising children and meal preparation, which tends to keep them around the house, has probably led to this type of division of labour. Indeed, many of the food plants gathered were shown to us by village women in close proximity to their homes. This study does not include the use of upland resources, nor does it investigate how labour is divided in this regard. Nevertheless, it is known that women are often responsible for the time-consuming tasks of collecting firewood and water, which may also preclude other harvesting activities to a large degree.

While labour within the household is divided among men, women and children, and gender roles are often quite strongly defined, the value of wetland resources must be seen as accruing to the household as a whole, and not to different genders or age groups. Division of labour largely serves to increase efficiency and productivity. However, men tend to have greater control over household cash income, being in charge of most transactions. Women generate their own income to some extent through selling beer and crafts, but most financial power is in the hands of men. Because of their generally stronger position in the social hierarchy, men tend to make decisions which affect the resources collected by all members of the household, and this has implications for the sustainability of many resources. For example, men may not appreciate the degree of scarcity of certain resources that they do not harvest themselves. While it may not be appropriate to interfere with the cultural norms of these societies by imposing western values on them, it is important that these factors are taken into account during policy formation and implementation, and in resource management and education programmes.

4.7.4 Effects of wealth on resource demands

In several cases findings indicated that households of different wealth status have different levels of demand for different resources. Wealthier households were generally larger, except in the Delta, where the reverse trend occurred. Wealthier households generally had more cattle and larger fields than poorer households. The apparent effects of wealth on demand for natural resources was very variable between resources and between sites. Wealth status did not have an impact on fishing in any of the sites.

In general, households in Caprivi with higher wealth status harvested more natural resources (palm leaves, reeds, papyrus and food plants) than poorer households, and a similar trend was found in the Delta for reeds and papyrus combined, grass, food plants and animals. Only in Barotse and Lower Shire was there any evidence for the often-assumed trend of decreasing dependence on natural resources with increased wealth. In Barotse, richer households harvested more reeds, but palm leaves and papyrus were harvested more by poorer households, and in Shire, poorer households harvested more reeds and papyrus (combined) and more grass than richer households. The higher demand for certain resources by richer households may be explained by several factors but the variability in these trends is difficult to explain, because a number of factors may be at play. Where richer households are larger this would lead to an increased demand, as well as increased personpower to collect resources: this might be the case in Barotse and Caprivi, but is not a possible explanation in the Delta. Richer households may also have more time to spare to collect resources, especially when they have paid labour for helping with agricultural activities. Poorer households would also only be expected to harvest more natural resources as a source of income where there is a good enough market for these products. This market might comprise the wealthier households as well as urban centres. However, wealth categories are relative, and even wealthier households may not be sufficiently well off to create a market for these resources. Generally, it is possible that richer households continue to harvest natural resources because it is profitable relative to other activities.

Caution must be exercised in interpreting these data, as the wealth rankings were the subjective assessment of the local enumerators, and their perceptions of wealth could possibly have differed from wetland to wetland. At two of the sites, Caprivi and the Delta, virtually no households were classified as in the top wealth category, which made analysis more difficult. We are thus unable to draw any strong conclusions from the wealth analysis.

4.7.5 Non-consumptive use value

Tourism value exists to some extent in all four study areas, but was only considered quantitatively for the Chobe-Caprivi, where it is likely to be largest at present. Tourism value is currently small in the Lower Shire and in Barotseland. In the Lower Shire, this is due to the degradation of the wetland area, especially the loss of elephants and other wildlife, dense human populations and degradation of existing tourism infrastructure, e.g. in the nearby national parks. Potential for tourism in Barotseland has probably also been compromised due to a loss of wildlife from the area, and the area is also relatively remote. Nevertheless, tourism will probably increase in the area. Despite the decimation of wildlife populations in the Delta, remaining populations and the vast unspoilt areas of the Marromeu

Buffalo Reserve provide this site with tourism potential which is currently limited by lack of infrastructure and the perception of lack of safety. Tourism is booming in the Chobe-Caprivi area, however, in spite of the fact that wild animals have also been all but eradicated throughout most of the study area. Tourism in this area is made viable by the gamefish resources and the presence of the Chobe National Park adjacent to the wetland areas. Of the overall annual net economic value of tourism in this region, we estimate that at least US$785 600 can be directly attributable to the wetland, although this value could easily be higher.

5 INDIRECT USE VALUES

5.1 DEFINITION OF INDIRECT USE VALUES

The indirect use values of wetlands are derived from the regulatory ecological functions that they provide. For example, the maintenance of water flow and quality, micro-climate stabilisation, shoreline protection, storm buffering or food web support all have an indirect economic value because they support or protect economic activities with directly measurable outputs (Barbier *et al.* 1997). Wetland regulatory functions, and the indirect economic values they give rise to in the Zambezi Basin study sites, are described in detail in the next section of this chapter.

In this study, indirect use values are further sub-divided into two additional categories: values arising from the maintenance of on-site land and resource productivity, and other on-site and off-site values associated with the regulation of water quality and flow. It is useful to separate these two categories of wetland indirect use value for analytical purposes because they have different economic implications in terms of the ways in which they are valued and the human populations they benefit. On-site contributions to productivity and resource utilisation opportunities are dealt with in chapter 4, because they support and maintain wetlands direct use values. This chapter is primarily concerned with the indirect use values generated by wetlands' regulation of water flow and quality.

5.2 OVERVIEW OF INDIRECT USE VALUES IN THE ZAMBEZI BASIN

Wetlands in the Zambezi Basin have many different ecosystem functions, which in turn provide indirect support to a wide range of economic activities (Table 5.2.1). While some of these functions and economic values are common to all of the study sites, others vary between different sites and their component habitats. They are described in detail in the paragraphs below.

Table 5.2.1. A summary of Zambezi Basin wetlands indirect values

Ecosystem function	Indirect economic values
Flood attenuation and water flow control	Prevention or reduction in damage to infrastructure, land, resources and associated settlement and production opportunities
Groundwater recharge and water supply	Provision of regular water supply and associated settlement and production opportunities
Sediment retention	Support to land and resource utilisation opportunities* Maintenance of water quality
Nutrient cycling	Support to land and resource utilisation opportunities* Maintenance of water quality and associated settlement and production opportunities
Shoreline protection	Prevention or reduction in damage to infrastructure, land, resources and associated settlement and production opportunities
Wildlife habitat, breeding and nursery functions	Support to consumptive and non-consumptive utilisation of fish, birds and animals*
Micro-climate regulation	Support to land and resource utilisation opportunities*
Carbon sequestration and storage	Mitigation of global warming-related damage to infrastructure and human settlements

*Note: *these values are concerned with land and resource productivity and are covered in chapter 4*

5.2.1 Flood attenuation and water flow control

The wetlands of the Zambezi Basin minimise flood peaks and reduce flow velocity because they store water (Breen *et al.* 1991). This ecological service is most relevant to the three inland study sites, the Barotse floodplains, the Chobe-Caprivi wetlands and Lower Shire wetlands, because it primarily affects inhabited areas downstream. These wetlands perform this function because they act as “sponges”, i.e. they hold water and even out its release (Winpenny 1991). At the onset of the rainy season, or in times of peak river flow, their large surface area to depth and volume ratios mean that they are able to absorb and spread out water over a large area (Thompson 1996). They can also help to maintain dry season water supplies, because "stored" water is then released slowly. The emptying of floodplains and wetlands may take up to four times as long as the period between initial and peak inundation. For example, Breen *et al.* (1991) cite Ward (1975) in estimating that the Barotse floodplain is capable of storing over 17.2×10^9 m^3 of water at peak floods, and may delay the flooding peak downstream by some three to five weeks. Wetlands and floodplains also reduce peak water flows through the spillway or reservoir effect they have during sudden or large floods.

The main economic values associated with flood attenuation and water flow control are the prevention of, or reduction in, damage to infrastructure, land and resources, and to their associated settlement and production opportunities. Both roads and settlements tend to be concentrated close to the banks of the Zambezi River and on the floodplains downstream from the three inland study sites. These areas all benefit from reduced levels of flood damage to crops, houses, roads and bridges, as well as a reduction in population displacement and in the spread of water-borne disease.

Maintenance of river flow in dry seasons also undoubtedly has positive dry season effects, by contributing both to domestic water supplies and water-dependent commercial production such as irrigated agriculture and hydropower generation, as well as maintaining a source of drought fallback for humans, livestock and wildlife (Thompson 1996). This is a significant economic benefit for populations living in the areas downstream from study sites, many of whose seasonal production and settlement patterns are based on movements into floodplain and river-adjacent areas in dry seasons, and who experience wide scale and recurrent droughts.

5.2.2 Groundwater recharge and water supply

Although there is disagreement about the exact role of wetlands in groundwater recharge, most authors are of the opinion that wetland hydrology is closely linked to interflow or groundwater flow (Breen *et al.* 1997). Because they hold and spread water over a wide surface area, all of the study site wetlands play some role in recharging groundwater in surrounding areas, often over many kilometres away from the wetland itself (Adams 1996). Wetlands also allow return seepage, which maintains downstream water flow during dry seasons and drought, and plays an important role in securing year-round water supplies for human populations (Thomson 1996). As well as replenishing aquifers and allowing shallow wells to be dug, the positive contribution of wetlands to water tables and soil moisture levels also allow for better crop production in floodplain and river-adjacent areas (Adams 1996, Hollis *et al.* 1993).

Groundwater recharge and water supply functions of wetlands have a high economic value for adjacent and downstream populations. A major proportion of the human population living in the Zambezi Basin relies on shallow-dug wells and boreholes for domestic water supplies (MERCSA 1999). This is especially true for many of the 28 000 rural households in the Barotse floodplain study site, 3200 households in the Chobe-Caprivi area, 58 000 households in rural areas of the Lower Shire, and 78 000 households in the Zambezi Delta (see chapter 4). Wetlands' contribution to soil moisture and floodplain vegetation also play an important role in enabling two major components of rural livelihoods in study sites, floodplain agriculture and livestock herding. This is especially important in dry seasons and times of stress. These values, although important, are not considered in this chapter because they are reflected in the direct use values associated with wetlands.

5.2.3 Sediment retention

The reduced velocity of water flow in wetlands, combined with the dense vegetation cover, means that they trap sediments, retaining them in the wetland area and preventing their transport downstream. During times of peak water flow, when sediment loads are high, floodwaters deposit sediments and nutrients onto the floodplain. As well as depositing nutrient-rich silt on riverbanks and floodplain areas, and thereby enhancing on-site soil fertility, the retention by wetlands of sediments deposited by "flood pulses" prevents downstream sedimentation and siltation, and enhances water clarity (Postel and Carpenter 1997).

Wetland sediment retention generates indirect use values both on and off-site. Although not considered in this chapter, enhanced soil fertility and land productivity has a huge economic value in terms of its contribution to floodplain and wetland-adjacent agriculture, livestock production and plant harvesting. These activities are extremely important to rural livelihoods in the study areas. For example, nearly 435 000 cattle rely on wetland vegetation on the Barotse Floodplain, 60 000 in the Eastern Caprivi, and 104 000 around the Lower Shire wetlands. A variety of forms of floodplain and riverbank agriculture are also practised in all the study sites (see chapter 4 on direct use values).

A range of downstream or off-site production and consumption activities in the Zambezi Basin are enabled or enhanced by wetland sediment retention functions, and are considered in this chapter. Of major importance are the variety of reservoirs and dams which supply hydropower and water, and are used for commercial and recreational fishing. These include the planned major reservoirs downstream of Victoria Falls, Lake Kariba, and Cahora Bassa in Mozambique, as well as numerous other small dams in all the study countries. Rates of soil erosion are high in riverine and upper catchment areas of the Zambezi (Breen *et al.* 1997), and the river transports high silt loads, especially during the rainy season. The three inland wetland sites trap sediment that would otherwise end up in dams, reducing their storage capacities and affecting fishing opportunities. In the case of the Zambezi Delta, sediment retention both by freshwater patches of vegetation and mangroves play an important role in protecting coral reefs and inshore fisheries from the effect of silt and sediment discharges.

5.2.4 Nutrient cycling

Wetlands function as biological filters through which industrial, agricultural and domestic wastewater pass, and play an extremely important role in removing these wastes from the water column. All wetlands retain water and reduce water velocity to some degree, removing effluents and sediments from the wastewater which passes through them by physical, chemical and biological means, and reduce downstream pollution loads through mineralisation and sedimentation processes (Ewel 1997). Of particular significance is the capacity of wetland plants and microbes to remove phosphorous, nitrogen, suspended solids, pollutants and pathogenic organisms. Theses are usually accumulated in bottom sediments and subsequently decomposed or converted from soluble to insoluble forms of pollutants, e.g. heavy metals (Ewel 1997). According to a Swedish study, the nitrogen abatement capacity of wetlands varies from 100-500 kg N/ha/year, depending on the type and locality of the wetland (Gren 1995).

By cycling nutrients, the Zambezi Basin wetlands keep water quality parameters at levels safe for fish, other aquatic organisms and humans (Postel & Carpenter 1997). This function is reflected in a wide range of indirect economic values, including those relating to fisheries production, avoidance of human diseases like diarrhoea, and costs saved on artificial water treatment or purification measures.

5.2.5 Shoreline protection

Wetlands slow down flood velocity, and their component vegetation and material deposits attenuate wave energy currents, providing a windbreak and physical buffer against storms. These functions act to minimise the forces which lead to the destabilisation of riverbanks and shorelines (Breen *et al.* 1997). In coastal areas, they also have the positive role of trapping silt and building up land mass (Winpenny 1991). Although these services are negligible for the three inland study sites, the shoreline protection functions of wetlands is of great significance to coastal areas of Mozambique around the Zambezi Delta, where serious shoreline erosion is occurring in areas of wetland degradation (Breen *et al.* 1997).

The indirect economic values associated with wetland shoreline protection functions in the Zambezi mainly relate to the protection that they afford to human settlement, infrastructure and agriculture. While the role of wetlands in enabling agricultural production and other direct use values in coastal areas is dealt with in chapter 4, this chapter considers the values associated with damage avoided to roads, bridges, houses and other infrastructure.

5.2.6 Wildlife habitat, breeding and nursery functions

The Zambezi Basin wetlands provide for a wide variety of biological niches and evolutionary adaptations, and are consequently rich in flora and fauna. Floodplains provide vital habitat because they are characterised by conditions to which flora and fauna have adapted, and their life cycles are often in tune with the seasonal rise and fall of water levels (Thompson 1996). The wetting of a dry floodplain by rising waters initiates the growth of micro-organisms that are basal in foodchains, many of which track the flood cycle, developing anew every year. They are fed by nutrients that come with the floodwaters each time the river spills out of its channel (Howard 1992). Wetlands provide especially important seasonal habitat for migratory fish, birds and mammals (Winpenny 1991). During floods, many aquatic organisms, including fish, leave the main river channel to make use of wetland habitats as spawning, breeding and nursery grounds. The inland freshwater wetlands of Barotse, Chobe-Caprivi and Lower Shire support large artisanal fisheries, providing over a million people with their basic protein requirements (see chapter 4 above). One of the most important commercial species of shrimp, *Penaeus indicus*, migrate in their post-larval state into the mangroves of the Zambezi Delta, which are used as nursery areas, ultimately providing large economic value to the offshore commercial fishery (Gammelsrod 1996). The Delta also provides a nursery function to other species of marine fish, some of them commercially important. The contribution to the value of the offshore fishery in not estimated in this study, but it is likely to be significant. An example of where the value of this function has been estimated comes from the Los Olivitos mangroves in the Gulf of Venezuala, which are estimated to contribute half the value of coastal fisheries through their nursery functions (Mäler *et al.* 1995).

The main indirect values associated with wetland provision of wildlife habitat, breeding and nursery functions are reflected in the direct use of wetlands resources, and are covered in chapter 4. These values are extremely important as they support current and potential future use of wetland resources. A number of national parks and wildlife areas have actual or potential hunting and tourism activities based on the high biodiversity supported by these functions. These include Liuwa Plains National Park in the Barotse Floodplain, Chobe National Park in the Chobe-Caprivi Wetlands, Lengwe National Park by the Lower Shire Wetlands, Marromeu Buffalo Reserve and three hunting concessions in the Zambezi Delta.

5.2.7 Micro-climate regulation

Wetlands play a role in stabilising regional climate. Because the Zambezi Basin wetlands are low in altitude, with broad expanses of water and a high soil moisture content, they influence local climatic conditions (Ellenbroek 1987). Such effects result in favourable vegetation types and climate for cropping and grazing in wetlands-adjacent areas. These functions are reflected in on-site direct use values, they are considered above in chapter 4.

5.2.8 Carbon sequestration and storage

Under natural conditions, organic soil wetlands and their vegetation act as net carbon sinks for atmospheric gases (Winpenny 1991). They thereby help to mitigate the effects of global warming as its associated economic costs. Typically, the values attached to this ecosystem function are large, often seeming theoretical and unbelievable to decision-makers. For example, Pearce (1990) estimated the indirect use values associated with the carbon storage function of tropical forests at US$1 300 per hectare. However, a more important issue is that even if the value is large for the Zambezi basin wetlands, it is likely that no institutional means currently exist for its capture. By identifying it as substantial, this study might turn decision-makers' attention to the future possibility of doing so. Currently, scientists and economists are busy doing valuations of carbon sinks as a result of the Kyoto Protocols and there are commissions and task forces trying to sort out how emission trading will work for carbon, all of which will implicitly generate prices. Nobody at this point is sure what sort of price this market will eventually generate but it is likely to be in the order of US$1-30 per ton of carbon removed from the atmosphere (H.J. Ruitenbeek, pers. comm.).

5.3 SCOPE AND FOCUS OF INDIRECT VALUATION

The preceding section has described the wide range of ecosystem functions, and their associated indirect use values, generated by Zambezi Basin wetlands. Given data constraints, and the relatively short time frame and limited budget of this study, it is impossible to quantify all these values. This study therefore concentrates on the indirect values that are likely to be the most significant to the region in economic terms, and for which available data permit quantification. While the contribution of wetlands to on-site land and resource productivity are covered in chapter 4 above, values arising from the regulation of water flow and quality form the focus of this chapter:

Flood attenuation: this is considered for both on and off-site populations below;

Groundwater recharge and water supply: domestic and commercial water use are considered for both on and off-site populations below, while the contribution of these services to on-site crop, livestock and resource productivity have been covered in chapter 4 above;

Sediment retention: protection of off-site production possibilities are considered below, while the contribution of this service to on-site crop, livestock and resource productivity has been covered in chapter 4 above;

Water purification: maintenance of on-site and downstream water quality are considered below, while the contribution of these services to on-site crop, livestock and resource productivity have been covered in chapter 4 above;

Shoreline protection: this is considered for coastal areas of the Zambezi Delta only, in this chapter.

Together, the four study sites cover most of the Zambezi Basin, from the upper reaches of the Barotse Floodplain on the western boundary of Zambia with Angola down to the entry of the Zambezi into the Indian Ocean through the Mozambique Delta. While some ecosystem functions are cumulative, e.g. water purification may occur in each wetland on the river's path to the sea, for the purposes of estimating the indirect use value of individual wetland areas, certain artificial boundaries are used in this study to delimit the influence of each individual wetland. Whereas on-site values are taken to refer to the study sites, consideration of some off-site values, such as water purification and sediment retention, is taken down to the next major wetland, reservoir or the sea. The boundaries to which the economic effects of these ecosystem functions are valued are given in Table 5.3.1.

Table 5.3.1. Boundaries of consideration of some off-site indirect use values in study areas

Basin component	Lower boundary of consideration of indirect use values, unless otherwise stated
Barotse Floodplain	Katima Mulilo, on Namibian border with Zambia, immediately upstream of the eastern floodplains of the Chobe-Caprivi Wetlands
Chobe-Caprivi Wetlands	Upper reaches of Kariba Dam, some 220 km downstream of these wetlands
Lower Shire Wetlands	Mopeia, on the Zambezi River in Mozambique, some 50 km down river from the Shire confluence with the Zambezi. Caia is taken to be the top end of the Delta wetlands
Zambezi Delta	Indian Ocean

5.4 METHODS FOR VALUING INDIRECT BENEFITS

Due to the fact that few ecological services have market prices, and because the indirect use benefits of wetlands arise from enabling, or providing underlying support to, economic activities, their value must be inferred using indirect methods (Barbier *et al.* 1997, Winpenny 1991). For the values considered in this chapter, four main categories of valuation techniques can be applied to wetland ecosystem functions (from Emerton 1998; refer also to chapter 2):

Effect on production: Wetlands services support economic production. For example, their water-related functions maintain downstream income, employment, production and consumption generated by hydropower, irrigation, urban water supplies, floodplain agriculture, grazing, fisheries and other wild resource uses. Where these economic activities have a market value it is possible to look at changes in production and consumption arising from changes in the status and integrity and wetlands. These effects on production reflect the indirect contribution of wetland services to economic output.

Damage costs avoided: Wetlands services, as well as generating economic benefits, help to avoid economic costs, for example, by maintaining water flow and minimising flooding, or by protecting riverbanks and shorelines. Calculating the value of damage occurring as a result of the loss or irrevocable degradation of wetlands, for example the costs of damage to houses, roads, bridges and farms caused by flooding, provides a way of valuing wetlands services in terms of losses avoided and costs saved.

Preventive or mitigative expenditures: Wetlands services can be valued by looking at how much it would cost to set in place measures to protect human or natural production systems, to prevent or mitigate the damage arising from their loss. For example, flood control barriers might be needed to offset or prevent negative impacts associated with the loss of wetland flood control services, or comprehensive basin erosion control measures might be needed to prevent reservoir siltation associated with loss of wetland silt-trapping functions.

Replacement costs: If wetland ecosystem functions and services are no longer available, it is sometimes possible to replace them by alternative means. For example, decline in wetland water storage functions might necessitate the construction of reservoirs and dams to provide year round water supplies. Loss of floodplain inundation could require the application of chemical fertilisers, while decreases in water quality would require the construction of water treatment and purification plants. The loss of riverbank protection may lead to the need for artificial reinforcement. These replacement costs represent the value of wetland services which can be at least partially replicated by artificial or man-made means. They reflect the expenditures saved by the presence of naturally occurring wetlands and their accompanying ecosystem functions.

Cost-based methods are most commonly used to value ecological services. These include damage costs avoided, preventive or mitigative expenditures and replacement costs. This often results in their under-valuation, and should be seen as a minimum value. The value of wetlands ecological services is far more than the costs their absence gives rise to. Replacement cost, preventive and mitigative expenditure approaches should be used with extreme care, because they make the implicit assumption that the replacement is worthwhile, and thus that its benefits exceed the costs of providing such benefits (Barbier *et al.* 1997). They also assume that the benefits of, and demand for, the artificial replacement, preventive or mitigative technology are the same as naturally occurring ecosystem services.

5.4.1 Problems of data availability

The choice of valuation methods in this study has been determined by:

the extreme scarcity of information available from Government Authorities and NGOs in the Zambezi Basin states;

the almost complete lack of work carried out to date on indirect values or on economic aspects of ecological services in Zambezi Basin wetlands; and,

a limited time scale and budget (see Barbier *et al.* 1997).

It has been necessary to choose valuation methods for which data are available, rather than those that are most ideally suited in theoretical terms to value wetlands ecological services. Wherever possible more than one method has been used, so as to present a range of value estimates. Descriptions of how these valuation methods were applied in valuing each wetland ecosystem function are given in more detail under each section.

One way to overcome this problem of poor data is to extrapolate data from similar circumstances elsewhere to the Zambezi. The application of values estimated for another site or time to the current situation is known as benefits transfer. Some authors think this is acceptable, for example, see Krupnick (1993) for a discussion of situations where benefits transfer may be appropriate. A series of studies testing the robustness of benefits transfer have recently been done that involved intra- and inter-country comparisons within Europe, as well as comparisons between European and other countries. The general approach was to do original survey work at each of the places, and then use benefit transfer approaches to transfer results among sites to see how far off from the 'real' numbers one would have been. The general conclusions of these studies is that using single number estimates (e.g., US$/ha, US$/person, etc) to transfer benefits from one site to the next generally generates acceptable estimates of 'real benefits'. However, transfer of the full benefits function (i.e., one where you compensate for economically important things like demographic structures, education, income levels, etc) generates unacceptable estimates of anywhere from 40% error and higher (Navrud & Pruckner 1997, Bergland *et al.* 1999, Ready *et al.* 1999). Given the potential for error with benefits transfer, so we do not use it unless no other data are available for alternative methods. It is not usually advisable, however similar the sites are, to use benefits transfer in wetlands valuation, since the same ecological, biological, market or socio-economic parameters usually do not hold (Barbier *et al.* 1997).

5.5 FLOOD ATTENUATION

There are two main options available for valuing the flood attenuation functions of wetlands. Either the damage costs avoided, or avoided effects on production, resulting from downstream flooding can be estimated, or the replacement costs or mitigative expenditures of taking action to develop flood control mechanisms such as barrages, dams and levees that could replace the flood attenuation function of wetlands can be calculated. This study chooses to use the first method, damage costs avoided, because it is a more realistic scenario which values likely costs, rather than using expenditures on technologies which are unlikely, in reality, to be set in place. The method also presents a fuller picture of the likely socio-economic benefits of flood attenuation services, rather than a minimum estimate of alternative expenditures.

The damage costs avoided or effects on production technique involves assessing the historical frequency of floods in study sites, their severity, area of impact, and the economic damage they give rise to in terms of destroyed agricultural production, commercial production and infrastructure. It also requires that changes in flood frequency and severity under different scenarios of wetland status are estimated.

An analysis of several hundred floods between 1995 and 1999 from various countries world wide indicates that most flood damage occurs in the wetland/ floodplain areas of river basins rather than along the river bank due to overtopping (DFO 1999, VITA 1999). Only river-crossing infrastructure, such as road/rail bridges, power and communications lines, and towns right on the river's edge or floodplain, sustain significant damage. Thus, the most likely value of upstream wetland flood attenuation in the Zambezi system is that it protects low-lying floodplain and wetland areas downstream. For example, if the Barotse wetlands were to become degraded, then the Chobe-Caprivi region would incur the greatest cost due to increased severity and extent of flooding.

The following section discusses the general assumptions that were made based on interviews with government officials and data adapted from other flood sites. The estimations made from these assumptions were standardised and applied to all sites.

5.5.1 Cost of temporary relocation or displacement of people

In response to the 1997 floods in the Lower Shire, USAID made available US$25 000 in aid for displaced people. The money was spent on food, shelter, blankets, medical and other relief supplies (OFDA 1997). In Mozambique, the government declared the area in Zambezia and Sofala Provinces south of the Shire a disaster area. USAID donated a further US$24 652 in relief aid to this area. Although several other agencies also donated minor amounts, there was a significant shortfall (OFDA 1997). Approximately 350 000 people were displaced for one to three months. The direct costs of this displacement to national governments and donor agencies are not precisely known, but were well in excess of US$100 000, implying a cost of at least US$0.30 per flood displaced person. Based on food, shelter and medical requirements for 10 000 people, calls for aid in response to recent floods in the DR Congo indicate a cost of closer to US$1 per displaced person (VITA 1999). This study uses a cost of US$0.5 for relief per displaced person. While this figure seems low (equivalent to approximately 3kg grain per person!), it is an average figure applied to all displaced people. In reality, it is more likely that only several thousand people would benefit by receiving aid worth tens of dollars per person.

5.5.2 Replacement and repair costs of damaged road and rail infrastructure

An estimated 35 million MK (US$800 000) is required to repair the major roads of Nsanje and Chikwawa in the Lower Shire valley after the past few years of flood damage, including the big flood of 1997. An additional 28 000MK/km (US$600) is also required to grade them after repairs (Mr Kuotcha, Ministry of Work, Roads Dept, Blantyre). There are an estimated 300km of formal gravel and tar roads in the area, which implies a repair cost of about US$3 250/km. The South African Department of Works costs remote rural gravel road repair work at about R25 000/km (US$4 100). The per kilometre costs of re-establishing 500 km of gravel and earth roads after flooding in the Tana River District, Kenya, were estimated in Kenya Shillings as follows: labour 185 000, gravel and materials 60 000, small tools 5 000, mechanical equipment 50 000, running costs for equipment 85 000, supervision 50 000, and miscellaneous 65 000. Since 50KSh = 1US$ at the time, the total of KSh500 000/km implies a re-establishment cost of US$10 000/km (Emerton 1994), which is two to three times the previously estimated post-flood repair costs.

The Tanzanian Railway Authority found that after the February 1999 floods, it would cost about US$9 100/km to repair the rail link with Dar es Salaam (Chintowa 1999). Based on the above information, this study assumes repair costs for roads at US$3 500/km and for rail track at US$9 000/km. Based on personal observations of the effect on roads of the 1998 Chobe-Caprivi flood and the 1997 Lower Shire flood, as well as interviews with the relevant road authorities, this study conservatively assumes that roads are never completely removed during flooding, and re-establishment costs are thus not used.

It could be argued that most of these road and rail links are need of maintenance work even in the absence of floods. However, these expenses would not be likely to obviate any of the repair costs required after flood damage to a significant extent. Due to the high level of uncertainty in estimating these costs, estimates in the following sections are given as ranges.

5.5.3 The Barotse Floodplain

The upper Zambezi is regulated by two large natural reservoirs - the Barotse floodplain and the Chobe-Caprivi wetlands (Mukosa *et al.* 1995). The Barotse floodplains have a storage capacity of 8.6×10^9 m^3 at normal flood levels, and as much as 27×10^9 m^3 at high floods with a retention time of at least one month. It has been estimated that there is a time lag of about 6 weeks before the occurrence of peak flood recorded above the Barotse floodplain and peak flood recorded at Victoria Falls (Mukosa *et al.* 1995).

The effect, or benefit, of this peak flood attenuation is felt primarily in the Chobe-Caprivi wetland system, the next major low-lying area downstream to the south. There are some rural households living along the Zambezi main channel, and especially on the floodplains of tributaries between Katima Mulilo and Senanga. The number of these is estimated and they are treated in damage estimation in the same manner as the households living in the Chobe-Caprivi system.

Mendelsohn and Roberts (1997) provide a detailed risk of flooding spatial assessment for the eastern floodplains based on the 1989 flood (approximately 1:10 year event). They also provide a less detailed assessment for all of Caprivi. Based on this, they estimate that a total of 3 640 households would be affected by maximum flood levels. The majority of settlements in the area are on ground slightly higher than the surrounding floodplain, and although situated in high-risk areas, they are usually spared from direct flood damage (Mendelsohn & Roberts 1997). However, fields and grazing pastures are usually on the floodplains and early floods will destroy crops and livestock that are not moved off the floodplain in time. Periods of extreme events, such as the floods between 1957 and 1969 (1:50 year events) will nevertheless cause extensive damage to household settlements.

Spatial data for the 1989 and 1998 floods were overlaid on 1:250 000 maps. It was estimated that 70% of Zambian fields, 50% Kabe fields and 20% of other Caprivi floodplain fields are flooded in a 1:10 event. It was assumed that 95% of all floodplain fields flood in a 1:50 event, especially if "lake" Liambezi fills, since it is all currently cultivated (from Mendelsohn & Roberts 1997). The numbers of cattle that die are assumed from DFO (1998) and focus group statements. It is assumed that a greater proportion of the herd than the current one third is moved off the wetland during high floods and the use value cattle model was adjusted appropriately to estimate loss in productivity. The percentages of structures lost or damaged were estimated from personal observations and interview statements. The replacement costs per settlement were based on the cost of 200 bundles of thatch grass, 40 bundles of reeds for walls/courtyards, US$10 worth of clay, mud, and poles and 4 days of labour time. Repair costs were set at 10% of replacement costs. In the low-lying Zambian portion, 70% of people were assumed displaced by a 1:10 event. In Namibia, 25100 people were estimated as the number likely to be affected by 1:50 event (Mendelsohn & Roberts 1997). One third of this was assumed for a 1:10 event.

Most "roads" in the area are informal tracks, and an estimated maximum length of 180km of formal roads could be damaged during flooding.. Only 25 km was estimated as flooded during the 1:10 event, mainly Schuckmansberg road, Ibbu road and bit of Katima-Ngoma road near Bukalo channel to Liambezi, plus an estimated 5 km in Zambia. For the 1:50 event, 45km of roads were estimated to be flooded by taking the coverage of the 1989 and 1998 floods and extending it across the Bukalo channel into Liambezi, flooding Liambezi and damaging roads around Chinchemane, as well as the Bukalo-Liambezi road and Lusese roads behind Bukalo. A further 20km of flooded road was estimated for Zambia. It was assumed that floods damage and destroy boreholes and wells in the same proportions as the assumed settlement damage. Estimations made in the assessment of flood damage under the current flooding regime, based on spatial data for various human activities in Mendelsohn and Roberts (1997), use value models, personal observations and other sources are given in Table 5.5.1.

This estimate of damage is for the specified event if it were to happen. In order to estimate the Net Present Value (NPV) of this damage, the 1:10 and 1:50 values are divided by 10 and 50 respectively, and then summed to give an annualised value of approximately US$98 000. The NPV of current flood damage to the area potentially attenuated by the Barotse Floodplains is approximately US$950 000 (r=8%; US$1 305 000-717 000, r=4-12%).

Table 5.5.1. Estimates of the nature and cost of flood damage in the area south of the Barotse Floodplain, up to and including the eastern floodplains of the Caprivi region. Estimates are given for high (1:10) and extreme (1:50) flood events

Damage type	Flood frequency 1:10 year event	1:50 year event
Area of fields flooded (ha)	18 000	44750
No. of cattle lost	10	500
No. of settlments damaged	5%	25%
No. of settlements destroyed	1%	5%
No. of lives lost	2	>20
No. of people displaced	13 389	34 400
Infrastructure damaged	25km roads, 4 boreholes, 6 wells	65km roads, 32 boreholes, 76 wells
Damage estimate (US$)		
Lost agricultural productivity	430 000-450 000	1-1.2 million
Lost stock and stock productivity	60 000-70 000	250 000-260 000
Cost of settlement rebuilding	20 000-22 000	100 000-105 000
Cost of human displacement	7 000-8 000	18 000-20 000
Cost of infrastructural repair	90 000-95 000	240 000-250 000
Total cost of flood event (US$)	607 000-645 000	1.6-1.8 million

The development of floods is a complex combination of hydrological, sedimentological, geomorphological and structural factors (Beven & Carling 1989). Wetland vegetation flattens and broadens peak flood flow reducing the steepness of flood spikes (J. Weaver and C. Colvin, CSIR pers. comm.). Furthermore, floodplain aquifers also reduce flood-peaks, since during flooding all the alluvium, or aquifer material, is saturated, thus absorbing some of the flood-water (J. Weaver CSIR pers. comm.). After the passing of the flood this saturated material slowly drains, thus releasing the stored water, which maintains river base-flow.

Steep flood spikes, or rapid rises in river levels, are likely to lead to much more devastating floods (J. Weaver and C. Colvin, CSIR pers. comm.). As a wetland becomes degraded through cultivation and vegetation removal, it becomes more canalized. Elephant Marsh in the Lower Shire is a good example of this, with many small deep channels having been formed in an area which 90 years ago had nothing resembling a channel more than 30cm deep (Maxwell 1954, cited in Timberlake 1997). The harvesting of reeds and grass along the water's edge, and the cultivation of all available land within the wetland area during dry periods, have facilitated the erosion of these channels (pers. obs.). During peak floods, water will flow through this area more quickly than through an equivalent area of healthy vegetated wetland. This implies that the peak flood will arrive more rapidly downstream, catching people by surprise and giving them less time to prepare for the flood or to evacuate. This faster rising of floodwaters is likely to result in higher damage to infrastructure, an increase in stock losses as stock become stranded, increased damage to flooded agricultural lands and a higher loss of human life. This study assumes that damage estimates to infrastructure and fields will increase due to the eroding nature of faster moving water flood waves. Revised damaged estimates for the area downstream of a degraded Barotse wetland are given in Table 5.5.2.

Table 5.5.2. Estimates of the nature and cost of flood damage in the area south of the Barotse Floodplain, up to and including the eastern floodplains of the Caprivi region, assuming a degraded Barotse wetland. Estimates are given for high (1:10) and extreme (1:50) flood events

Damage type	Flood frequency 1:10 year event	 1:50 year event
Area of fields flooded (ha)	20 000	48 000
No. of cattle lost	100	1 000
No. of settlments damaged	0.1	0.35
No. of settlements destroyed	0.05	0.1
No. of lives lost	>50	>100
No. of people displaced	15 000	38 000
Infrastructure damaged	35km roads, 10 boreholes, 20 wells	75km roads, 50 boreholes, 100 wells
Damage estimate (US$)		
Lost agricultural productivity	580 000-600 000	1.4-1.5 million
Lost stock and stock productivity	75 000-80 000	310 000-315 000
Cost of settlement rebuilding	80 000-82 000	180 000-185 000
Cost of human displacement	7 000-8 000	20 000-22 000
Total cost of flood event	870 000-900 000	2.2-2.3 million

The NPV of the revised flood damage to the area potentially attenuated by the Barotse Floodplains if they were degraded is approximately US$1.35 million (r=8%; US$1 806 000-990 000, r=4-12%).

5.5.4 The Chobe-Caprivi wetlands

Below the Chobe-Caprivi floodplain system, the river travels some 80km before it plunges over Victoria Falls and becomes trapped in a narrow gorge, and lower down within relatively steep hills, until it flows into Lake Kariba. While flooding down this portion of the river would in all likelihood affect several thousand rural people engaged in small amounts of floodplain agriculture and cattle pasturing and watering, this impact is unlikely to be significant. Most of these people do not plant according to flooding regimes, but in response to rainfall. Furthermore, stock losses are avoided by removing stock to the hills during floods, Damage to household settlements is minimal as they are mostly constructed in areas higher than the average high flood (1:10 year event). Flood attenuation values for this study area were thus not estimated.

5.5.5 The Lower Shire wetlands

The Lower Shire wetlands are somewhat anomalous when it comes to flooding regimes. As mentioned in chapter three, the severity of flooding in the Lower Shire valley and beyond into Mozambique depends on several factors. These include the flooding regime of the Zambezi River resulting in backflooding, the occurrence of high rainfall in the immediate catchment, flooding from tributaries such as the Ruo River, and flooding from upstream and Lake Malawi overflow. Nevertheless, the wetlands of the Lower Shire do afford protection from floods for the numerous households exploiting the rich low-lying alluvium soils in the area between the Shire, Ziu Ziu and Zambezi Rivers, and to the east of Ndinde marsh (Sweco 1982).

The Lower Shire valley is relatively narrow and flooding events can occur rapidly, with waters rising by as much as half a metre per day in Elephant Marsh (Mr Shirwa, Hydrology Section, Ministry of Water

Development, pers. comm.). Due to the linear nature of a series of Marshes, the top Marshes perform a flood attenuation function for the lower Marshes, complicating the issue. Furthermore, the Ruo River enters the system midway at Bangula Marsh, missing Elephant Marsh, again complicating the issue.

The Shire forms only 13% of the Zambezi catchment and, due to its regulated nature, less than 4% of Zambezi River flow (Sweco 1992). Historically, the Shire River has not had a significant individual impact in terms of causing flood damage to the main Delta wetlands area. Furthermore, the Delta is an anomaly as it is drying out due to reduced Zambezi flows (Sweco 1982). Flooding from the Shire into this region may well be a benefit in terms of ecosystem maintenance, flushing out salt water, clearing channels and flooding areas to the extent that fish may breed etc. However, with areas of the Delta drying out and becoming more permanently settled, it does become more susceptible to economic damage from large floods. The effect of Shire floods on the Delta is highly variable and unknown, and will not be valued in this study. The assessments of flood damage, and the resulting flood attenuation benefit, of the Lower Shire wetlands was thus limited to the southern portion of Ndinde Marsh, areas to the south and east of Ndinde Marsh, and a small portion of the Zambezi floodplain downstream from the confluence of the Shire and Zambezi Rivers.

The Hydrology Section, Ministry of Water Development is responsible for historical flood data in Malawi. However, this section has been "non-functional" for several years in Blantyre and all data was removed to Lilongwe, where it has subsequently been lost. According to Sweco (1982) and OFDA (1997), three large floods have hit the area of concern in past three decades, and have been classified by this study as 1:10 year events. Data from the 1978 flood have largely been ignored, despite this being the worst flood of all three. This is because the flood was precipitated by huge releases from Cahora Bassa dam and was exclusively due to high Zambezi floodwaters (Sweco 1982). The 1981 and 1997 floods were due to flooding of the Shire and its tributaries, and heavy rain in the surrounding catchments.

Spatial data for the 1981 flood was overlaid on 1:250 000 maps (from Sweco 1982). It was estimated that 90% of fields are likely to be flooded in a 1:10 year event. OFDA (1997) does not mention stock losses and 50 cattle were assumed drowned. Focus groups noted that cattle are usually moved off the wetlands well before the flood, but sudden flooding often results in stock loss. It is assumed that the herd is moved off the wetland for one month longer during high floods and the use value cattle model was adjusted appropriately to estimate loss in productivity.

The percentages of structures lost or damaged were estimated from personal observations, interview statements and OFDA (1997) press releases. The replacement costs per settlement were based on the cost of 200 bundles of thatch grass, 40 bundles of reeds for walls/courtyards, US$10 worth of clay/mud, and poles and 4 days of labour time. Repair costs were set at 10% of replacement costs. About 90% of the approximately 450 000 people in the potentially flooded area are likely to be affected by a 1:10 event (estimated from 1:250 000 map and area of 1981 flood in Sweco 1982). This agrees with OFDA (1997) who state that 400 000 people in Malawi and Mozambique combined were affected by the 1997 flood and 300 000 people were evacuated or displaced from their homes. A maximum of 75km of roads in southern Malawi that qualify as benefiting from having Elephant Marsh performing a flood attenuation function above them. Most of the 200 km of roads that benefit lie in Mozambique and include: Malawi border to Mutarara road, Mutarara to Pinda road, Mutarara to Chingano road, and part of the Chemba-Caia-Chupanga road. About 100km are estimated to be flooded in a 1:10 event, mainly in the area below Ndinde Marsh and along the main banks of the Zambezi. There are about 175km of railroads in the potentially flooded area, of which about 20km are susceptible to 1:10 year events (estimated from Sweco 1982, 1:250 000 maps where rail is low-lying and close to rivers, and pers. obs. while in Malawi). During the 1997 floods, almost all borehole infrastructure was destroyed and had to be replaced or repaired in the Lower Shire (A. Mahone, Concern Universal, pers comm.). This study assumes 20% of the 4000 wells and 2000 boreholes in the potentially flooded area receive flood protection from the Lower Shire wetlands. At least 80% are assumed damaged during a 1:10 event.

Estimations made in the assessment of flood damage under the current flooding regime, based on spatial data for various human activities in Sweco (1982), use value models, personal observations and other sources are given in Table 5.5.3. Data have not been presented for a 1:50 year flood scenario. No accurate records of events greater than the three previously mentioned floods are available for the Shire River. There were greater floods on the Zambezi in the 1940s and 1950s prior to the closing of Cahora Bassa and Kariba, but since then significant flood events have ceased (Sweco 1982). This implies that only 1:10 year flood events, like the two previously mentioned, are likely to occur, especially given that Lake Malawi is drying out (Timberlake 1997), and that barrages are planned for the Shire River above Chikwawa (Mr.Wengawenga, Ministry of Water Development, Blantyre, pers. comm.).

Table 5.5.3. Estimates of the nature and cost of flood damage in the area south of the Lower Shire wetlands, including the southern part of Ndinde Marsh, the floodplain area between the Shire, Ziu Ziu and Zambezi Rivers and the Zambezi floodplain running towards Mopeia. Estimates are given for high (1:10) flood event

Damage type	**Flood frequency** **1:10 year event**
Area of fields flooded (ha)	81 680
No. of cattle lost	50
No. of settlments damaged	10%
No. of settlements destroyed	2%
No. of lives lost	>70
No. of people displaced	300 000
Infrastructure damaged	100 km roads, 20km rail 480 boreholes, 960 wells
Damage estimate (US$)	
Lost agricultural productivity	8.37-8.38 million
Lost stock and stock productivity	250 000-260 000
Cost of settlement rebuilding	240 00-250 000
Cost of human displacement	150 000
Cost of infrastructural repair	1.74-1.76 million
Cost of human life	?
Total cost of flood event	10.75 - 10.8 million

This estimate of damage is for the specified event if it were to happen. In order to estimate the Net Present Value (NPV) of this damage, the 1:10 value is divided by 10 to give an annualised value of approximately US$1 080 000. The NPV of current flood damage to the area potentially attenuated by the Lower Shire wetlands is approximately US$10.6 million (r=8%; US$14 620 000-8 040 000, r=4-12%).

Based on similar assumptions as applied to the Barotse wetlands, revised damaged estimates for the area downstream of a degraded Lower Shire wetland are given in Table 5.5.4.

Table 5.5.4. Revised estimates of the nature and cost of flood damage in the area south of the Lower Shire wetlands, including the southern part of Ndinde Marsh, the floodplain area between the Shire, Ziu Ziu and Zambezi Rivers and part of the Zambezi floodplain running towards Mopeia. Estimates are given for high (1:10) flood event assuming a degraded wetland

Damage type	Flood frequency 1:10 year event
Area of fields flooded (ha)	85 500
No. of cattle lost	250
No. of settlments damaged	0.2
No. of settlements destroyed	0.05
No. of lives lost	>100
No. of people displaced	325 000
Infrastructure damaged	120 km roads, 30km rail 500 boreholes, 1000 wells
Damage estimate (US$)	
Lost agricultural productivity	10.5-10.6 million
Lost stock and stock productivity	260 000-270 000
Cost of settlement rebuilding	560 000-570 000
Cost of human displacement	160 000-165 000
Cost of infrastructural repair	1.9-2 million
Total cost of flood event	13.4 - 13.6 million

The NPV of revised flood damage to the area potentially attenuated by a degraded Lower Shire wetland is approximately US$13.3 million (r=8%; US$18 390 000-10 100 000, r=4-12%).

5.5.6 The Zambezi Delta

There is no flood attenuation value downstream of the Delta as it terminates in the Indian Ocean. While there is undoubtedly some flood attenuation within the wetlands itself, with wet grassland areas higher upriver around Marromeu and Luabo absorbing peak floodwaters and thereby protecting areas downstream, the highly altered flow regime of the Zambezi River make such "benefits" difficult to estimate, if indeed they are benefits. With much of the Delta drying out due to reduced flow, and areas becoming encroached by *Acacia* woodlands, people are settling where they previously were unable to, making damage estimation and assignment of values complicated. For this reason, the indirect use value of this ecosystem function was not estimated for the Delta.

5.5.7 Discussion of flood attenuation values

Table 5.5.5 shows the NPV of damage estimates for the current flooding regime, the NPV of damage estimates for degraded wetlands, and the estimated net benefits of each wetland's flood attenuation function. Several sources of error in assumptions and estimates imply that these values should be considered as ball-park figures rather than accurate estimates of value. The area of fields cultivated may vary tremendously from year to year, dependent on rainfall conditions and height of the previous year's flood. The mix of crops may also differ annually, and the mean annual value applied from the use value models may not be the appropriate measure of lost productivity value in some other year. The number of boreholes and wells damaged may be substantially higher or lower than the assumed number, as this data was based on general statements made during interviews with the relevant water authorities. The estimate of the number of kilometres of roads flooded was based upon rough spatial analysis of flooded areas being overlaid on contour maps, and may be out by 20-30%. All roads and rail that are flooded may not require substantial repair after floodwaters subside. Furthermore, some roads that are known to exist in and around the study area did not appear on the maps, adding to the variance in estimated values. These values may thus be out by as much as 30-40% in either direction.

Table 5.5.5. Estimates of flood attenuation values for the Barotse Floodplain and the Lower Shire wetlands, based on damage costs avoided through the maintenance of healthy wetlands ecosystems

	Barotse Floodplain	Lower Shire wetlands
NPV of current damage estimated below wetland (US$)	950 000	10.6 million
NPV of damage estimated below degraded wetland (US$)	1 350 000	13.3 million
Flood attenuation value of wetland (US$)*	400 000	2.7 million

*Difference between current damage estimate and revised estimate for to degraded wetland

The estimated value of US$10 million for damage caused by a flood of the order of magnitude similar to 1997 Lower Shire one compares favourably with the estimate made by Sweco (1982) for the 1978 flood that flooded the entire Lower Zambezi valley. They estimated the total damage costs at US$62 million for an area some 8 times as large as the area estimated to be flooded below the Lower Shire wetlands in 1997.

These estimates of damage should be considered as minimum estimates for a number of reasons. The estimates of costs of displacement only include relief aid costs, and not costs incurred due to stresses on infrastructure where refugees are based, or social upheaval and loss of industry and business opportunities while people are displaced. Loss of agriculture only considers loss of standing crops, ignoring large possible losses of stored foods and other natural resources such as bundles of thatch grass, reeds and papyrus (OFDA 1997). Settlement damage is only estimated for structures and assumes that people had sufficient time to remove personal belongings ahead of rising floodwaters, which is not always the case. Estimates of damage to road and rail infrastructure do not include estimates of lost revenue due to road/rail closures preventing goods and tourists from entering the area during and post flooding.

A further assumption was made regarding the value of crop losses. If the flood is early and not too sudden, and villagers have warning, then they usually stay on in the area and try to harvest or protect their crops and homes. If the flood then increases in severity, damage is high as homes, crops and lives are lost. On the other hand, if the flood is late and villagers are warned, they have usually already harvested, and so they simply pack up everything and move off. Flood damage in this case is minimal (Mr Wengawenga, Ministry of Water Development, Blantyre, pers. comm., focus groups). Nevertheless, people in the Lower Shire have, on at least one occasion, ignored flood warnings to their considerable detriment (Osborne Shera, Chief Hydrologist, Malawi Ministry of Water Development). We simply dealt with this by taking 50% of estimated damage, implying 50% chance of early or late flood in any event.

It should also be noted that after large floods, rural households usually gain benefits from good yields in the following year, including good natural resource harvests, fish catches and improved grazing (see focus groups trends as reported in chapter 4). Theoretically, additional benefits due to extreme floods should be offset against their costs for a true economic picture. However, no quantification of such benefits was undertaken in this study.

There exists one major railway in the Lower Shire area, which runs from Caia to Sena, where it crosses the river to Muturara. One branch then connects the Mozambican railway with Blantyre in Malawi, running up the side of all three Marshes in Malawi. This rail infrastructure was extensively damaged in the 1997 flood when sections were washed away in some areas. The damage to rail was included in the damage estimate for the Lower Shire. However, the Mozambican section is unlikely to be functioning and there are "no real plans afoot to replace the rail link as there is no capital and the country is not getting enough benefit from this cost" (Mr Kuotcha, Ministry of Work, Roads Dept, Blantyre). Some people would argue that the inclusion of this cost would result in an overestimation of flood damage. However, both Malawi and Mozambique are embarking on progressive development plans and the rail link between Beira and Blantyre will no doubt be of vital trade importance in the future, and hence was included for this reason.

5.6 GROUNDWATER RECHARGE AND WATER SUPPLY

The groundwater recharge and water supply functions of wetlands can be most easily valued by looking at the costs of replacing existing shallow-dug wells, which depend on the groundwater recharge and water supply functions of wetlands, with other forms of water supply such as boreholes, water trucks or water pipelines. An alternative valuation method is to assess the losses in productivity arising from a falling water table and depleted aquifers. Due to the difficulties in estimating water-dependent production functions, the first method, that of replacement or mitigative costs, is used in this study.

The replacement cost approach involves assessing the extent of flooding, its contribution to the depth and replenishment of water tables and aquifers, as well as the impacts of changes in wetland status on these variables – the importance of wetlands in local water balance. The number of people using shallow-dug wells and boreholes within each area, and the costs of shallow-well and borehole provision, and the development of alternative water sources must also be estimated.

5.6.1 The Barotse Floodplain

Based on an understanding of the nature and extent of the wetland, the underlying soils, borehole hydrographs and relative water table levels (JICA 1995), and the rainfall and flood cycles of this study area, it can be concluded that Barotse floodplain does not contribute significantly to the groundwater supplies of the broader region (J. Weaver and C. Colvin CSIR pers. comm.).

The Barotse floodplain is enclosed on both sides by sand dune ridges some 20-50m high, behind which is higher lying flat land with dambos and other floodplain systems that remain moist from contact with the shallow water table in the uplands. This water table is maintained throughout the year by the high summer rainfall of 730-1000mm per year. The whole area within which the Barotse floodplain lies comprises permeable Kalahari sands. This area stretches from Angola across Western Province and south towards the Capivi. These sands are moist all the way through to the underlying Karoo sequence. They are 150m thick and more, and they form one great aquifer, perhaps the greatest in southern Africa. The water table throughout this aquifer is reasonably shallow, with high quality water, presenting a huge untapped potential for water supply. The shallow water table is due to permeable sands and high rainfall, and is not due to the effects of the Baroste wetlands. In fact, the floodwaters that inundate the Barotse floodplain for three to four months each year have very little impact on the groundwater recharge rate of this larger aquifer, although the year round flow in the Zambezi River itself contributes to some degree in the dry season (G. Hubert, E Martinelli & Associates pers. comm.). The flood level of 2-3 m above river height will have the effect of raising the water table on the floodplain itself, and in the areas immediately adjacent to the floodplain. However, upland areas away from the floodplain margins will feel no effect from this flood, remaining sustained by the larger rain-fed aquifer.

The timing of water table recharge in this upland area, as indicated by borehole hydrographs, largely corresponds in all case with the rainy season (October-March/April). This seems to indicate no major connection with the flooding regime of the Barotse wetlands, although it is impossible to tell whether or not the end of the recharge cycle is influenced by this flooding. A cross-sectional analysis of relative water table levels indicates that the water table in the uplands lies up to 10 metres higher than the water table on the floodplain, even though they lie at similar depths below the surface in both areas (JICA 1992). The floodplain margins are important settlement and crop production areas because they actually form seepage zones where the water table from the upland dambo areas meets the surface as groundwater flows downhill towards the wetlands (JICA 1992). The Baroste wetlands do not thus contribute significantly, if at all to maintaining shallow water tables in the nearby uplands.

On the floodplain itself, however, groundwater recharge from the wetland areas has an important local benefit. During the dry season, the water table lies only a few metres below the surface, facilitating the construction of cheap shallow-dug wells and shallow boreholes (7-20m on floodplain, Mr Zimba, Dept Water Affairs, Mongu). This allows the population in the study area access to safe drinking water of reasonable quality. It should be noted that many people simply use water directly from the main rivers and side channels in the area. However, the risk of disease is greater than if groundwater sources were used, especially if the water becomes bacterially contaminated from discharges into the wetland, such as near the sewage outlet at Mongu (Mr Zimba, Dept Water Affairs, Mongu). As a general rule, 30m of horizontal movement through the aquifer material is sufficient to remove most pathogens from water, which results in groundwater being a valuable asset in areas of poorer surface water quality (J. Weaver and C. Colvin CSIR pers. comm.).

The long period of inundation of the Barotse floodplain indicates that rates of groundwater infiltration into the larger regional aquifer are low, since the water subsides primarily due to runoff over several weeks rather than due to infiltration into the permeable Kalahari sands. This is probably because the floodplain aquifer is rapidly filled to saturation after which no more recharge is possible. Groundwater recharge values associated with the wetlands are thus local, and restricted to the floodplain and its margins (J. Weaver and C. Colvin CSIR pers. comm.).

5.6.2 The Chobe-Caprivi wetlands

The Chobe-Caprivi region is more arid than the Barotse region, with a rainfall of about 650mm per year in the far east at Kasane and Katima Mulilo, dropping rapidly down to less than 500mm per year in the Linyanti floodplains some 150km to the south-east. Groundwater supplies are thus likely to be more important to local people in this system than in the Barotse wetlands.

There are no steep borders to the Chobe-Caprivi wetlands, but rather the land inclines gently towards the west, resulting in the shallow water tables associated with the eastern floodplains extending throughout the Kabe and Katima Mulilo constituencies (Mendelsohn & Roberts 1997). Further away from the wetlands of eastern Caprivi groundwater is deeper and underlain by saline water (C. Colvin pers. comm., Mendelsohn & Roberts 1997). This implies that groundwater in these regions is a less secure water supply, because if it is over-pumped, it will become saline and unpotable, such as the case around the Linyanti area (C. Colvin pers. comm., Mendelsohn & Roberts 1997). Thus, as is the situation in the Baroste wetlands, groundwater is of local importance only as a cheap accessible water supply to floodplain-dwelling populations.

Groundwater reserves are abundant in the study area and water tables are generally fairly close to the surface, lying between 10 and 40 metres below the ground depending on the area (Mendelsohn and Roberts 1997). Near the main rivers and permanent channels, the water table may be as shallow as 2-3 metres below the surface (V. Simanya, pers. comm.). Mendelsohn and Roberts (1997) estimate that 32% of households in Caprivi obtain their water from rivers and other surface waters, 26% obtain their water from wells, 24% from piped sources and 16% from boreholes.

There are 39 boreholes in Kabe, with a further 176 in the adjacent Katima Mulilo constituency (Mendelsohn & Roberts GIS data) which are likely to be accessing the same groundwater supplies as in the study area. The quality of groundwater in and around this area is almost always good to excellent (Mendelsohn and Roberts 1997). Assuming a similar density of boreholes in the Zambian portion of the study area as on the eastern floodplain (2 per 10 000 ha), there are a total of 224 boreholes which this study considers to benefit directly from groundwater recharge associated with the Chobe-Caprivi floodplain system. There is no data on how many of these boreholes remain in productive use. According to the Namibian Department of Water Affairs, there are at least twice as many shallow-dug wells on the eastern floodplains as there are boreholes, possibly many times more than the number of boreholes, because wells are the primary source of water in these areas (V. Simanya, pers comm.). Since accurate figures do not exist, this study assumes 250 shallow dug wells that access groundwater reserves, based on a total of 108 floodplain boreholes (Mendelsohn and Roberts GIS data).

5.6.3 The Lower Shire wetlands

The Lower Shire wetlands lie in a deep valley around Elephant Marsh, with Ndinde Marsh bordered by a steep escarpment on the western side. Given the steep gradients of these natural enclosing features, it is unlikely that the groundwater recharge function of the Lower Shire wetlands has any impact beyond 5 km from the margins of the actual wetland area (J. Weaver and C. Colving, CSIR, pers. comm.). This area of effect approximates our defined study area of 243 000 ha, of which 162 000 ha are actual wetlands.

While the water table on the floodplain is shallow (12-15m), mean borehole depths of 35-45m on the floodplain itself are due to the fact that the Ministry of Water Development and NGOs are drilling deeper than the water table level in order to avoid contaminated water (Mr Wengawnega, Ministry of Water Development, Blantyre, A. Mhone Concern Universal). Surface water quality in the Lower Shire wetlands is poor due to high untreated runoff from Blantyre and Limbe (550 000 people) into the Shire catchment, and to the high numbers of rural people with no access to formal sewers or advanced pit-latrines. (Mr Wengawenga, Ministry of Water Development, CarlBro Group 1995). Drilling to such depths implies that boreholes may be accessing deeper groundwater that is not influenced or recharged by the wetland itself, or is recharged over extremely long timeframes. One would need a geological cross-section or drilling logs to establish the continuity of groundwater from shallow to deep, and such data apparently does not currently exist for the Lower Shire (Mr Wengawenga, Ministry of Water Development, Blantyre). This study assumes that the wetlands are responsible for recharging the aquifer being accessed for groundwater.

5.6.4 The Zambezi Delta

Most of the Delta region lies on alluvial soils, and the water table depends on flood and rainfall regimes, rising and falling on the floodplain according to flood levels. Areas immediately adjacent to the Delta floodplain would benefit from a high flood level with a corresponding rise in their water tables, much the same as along the Baroste floodplain margins. Groundwater recharge is thus only of local importance to wetland, floodplain and floodplain margin dwelling populations.

Schmidt (1997) gives data for the number of boreholes and shallow-dug wells in the Delta regions of Marromeu, Mopeia and Chinde. There are a total of 80 boreholes and 65 wells in the region, of which 51 and 21, respectively, are still functional. This figure is low when compared on a per capita basis to the other wetlands under study. Many people utilise the river and backwater channels directly as a source of drinking water (pers. obs.).

5.6.5 Discussion of groundwater recharge and water supply values

Given that it has been established that groundwater recharge values are localised to the wetland and floodplain areas, the complex relationship between river flow, vegetation cover and flood extent needs to be investigated to determine the direct hydrological impact of the wetland on recharge rates. Such data does not exist for our study areas, and so we need to make some assumptions in order to value this function. If a wetland becomes degraded, it often becomes canalized. Water flow becomes restricted to channels, leading to drying out of the normally inundated vegetation areas. This will in turn lead to salinisation of groundwater below the dry islands, as is found in the Okavango Swamps. Below the islands, through the decades, salts have been concentrated in the groundwater by trees transpiring/ sucking groundwater, leaving behind salts. Water seeps from the channels towards the islands, creating an endless cycle (J. Weaver, CSIR pers. comm.). In a healthy wetland during non-flood periods, channel recharge of groundwater will dominate. However, during flooding, vertical groundwater recharge dominates. So if channeling of the river in degraded wetlands reduces flooding and inundation periods, then groundwater recharge will also be reduced and local floodplain water table levels would drop (J. Weaver and C. Colvin CSIR pers. comm.). This agrees with Thompson and Goes (1997) who found that in the Hadejia-Nguru wetlands, a reduction in flooded area by 25% in 1995/6 resulted in a 1-4 metre drop in groundwater tables.

During drought years in Mongu, "almost half the wells on the floodplain edges can dry up" (Mr. Zimba, Dept Water Affairs pers. comm.). In the Lower Shire, water provision NGOs found that "many of the wells on the floodplain dry up and people need access to boreholes for groundwater" (A. Mahone, Concern Universal pers. comm.). In Chobe-Caprivi, villagers complain that wells around Bukalo, less than 35km from the main river channels, dry up towards the end of the dry season and that there is insufficient water for stock during this time (*Kuta* headmen, pers. comm.). Based on qualitative information, this study assumes an estimated 35% of wells will dry and have to be replaced by boreholes should the wetland become degraded, cannalised or dried out.

The number of boreholes and shallow-dug wells in each wetlands/floodplain area, and their associated construction costs, are given in Table 5.6.1. This information is used to calculate the additional cost of having to replace 35% of wetland shallow-dug wells with boreholes under a scenario where the groundwater recharge function of the wetland is absent or highly diminished. This additional cost of water provision represents a proxy value for the ecosystem function of groundwater provision by healthy wetlands to local populations.

Furthermore, when wells and boreholes dry up, people often revert to using poor quality water from contaminated wells and boreholes, and backwaters, resulting in diarrhoea and other diseases with consequent economic costs. While no data are available for the numbers of people currently or potentially affected in this way in the wetland study areas, this study makes some benefits transfer assumptions based on a study by Pegram *et al.* (1998). They estimated the annual costs of diarrhoea and dysentery in Kwa-Zulu Natal, South Africa, to be approximately US$24 per case, including treatment costs and lost productivity through lost labour hours and care provision by family members. This study assumes US$20 per case due to the lower opportunity cost of labour hours in the study areas. A single dysentery epidemic can affect up to 50% of a rural population (Pegram *et al.* 1998). This study assumes that each study area would experience a single epidemic if water table levels were reduced to the point where the construction of boreholes to replace wells was needed, since many villagers would simply utilise poor quality water during the construction period.

Table 5.6.1. The number of boreholes and shallow-dug wells in each wetland area, their construction costs (US$) and the NPV of groundwater recharge (US$) as measured by estimating the additional construction costs and health costs that would be incurred by reduced groundwater recharge due to wetland degradation

	Barotse	Chobe-Caprivi	Lower Shire	Delta
No. of floodplain boreholes	220	108	2 000	80
Cost per borehole (US$)	2 220	2 500	2 500	2 000
Mean depth per borehole (m)	20	27	40	?
No. of shallow-dug wells	2 200	250	4 000	65
Cost per well (US$)	100	120	120	100
Mean depth per well (m)	7	10	12	?
Current infrastructural costs (US$)	708 400	300 000	5 480 000	166 500
Potential additional water provision costs	1 709 400	218 750	3 500 000	45 500
Possible health costs	3 500 000	300 000	4 000 000	3 200 000
NPV of groundwater recharge	5 200 000	500 000	7 500 000	3 200 000

These values should be considered minimum estimates for several reasons. Mendelsohn and Roberts (1997) note that groundwater levels have dropped as a result of poorer rains in recent years, and in some areas such as to the north of the Linyanti swamps, groundwater is salty and unfit for human consumption. Given the salinisation issue raised above, excessive use of boreholes may result in groundwater becoming salinized and unpotable. The extent of groundwater reserves thus need to be established in order to value them accurately. One may not be able to say that all 35% of wells could be replaced with boreholes since they may well have to be replaced with alternative, more expensive forms of water supply such as piped water, resulting in a higher value for current shallow well water provision.

The value of US$45 500 for the Delta region is very low and reflects the total lack of current water provision infrastructure in the region rather than simply a low value for this wetland ecosystem function. There is a need for increased availability and access to safe drinking water in the Delta, and many people suffer from diseases related to poor water quality, incurring a cost to household production possibilities (Schmidt 1997). The potential to increase the benefits of this ecosystem service through the provision of well and borehole infrastructure is thus large in the Delta region.

There is an additional value of groundwater infiltration, that of vegetation maintenance. In the floodplain, where groundwater is recharged by the wetlands, and the water table is more shallow, vegetation such as trees and reeds etc. which are adapted to such conditions would have water tolerant root systems which may not be able to track falling water tables under degradation scenarios. The survival of plants with water tolerant root systems may be something of an on/off phenomenon, and a smoothly falling water table level could even lead to a discontinuity once it gets below maximum root levels. This vegetation, which currently contributes significantly to the economic values associated with natural resource use (see chapter 4), could suddenly die off if groundwater recharge is reduced, or slowly be replaced with other vegetation types that have much lower use values attached to them. This basic ecosystem service thus permits the existence of entire classes of value, such as 'natural resource use', and plays a vital role in the maintenance of rural people's livelihood strategies.

5.7 SEDIMENT RETENTION

The off-site benefits of wetland sediment retention services can be estimated in a number of ways. The effects of this wetland ecosystem function on downstream production, including water supply reservoirs, hydropower dams and fisheries, can be estimated by assessing the preventive or mitigative expenditures necessary to offset the effects of the wetland loss, such as installing sediment traps, filtering and cleaning water. Alternatively, a proportion of the actual damage costs incurred to maintain existing infrastructure, such as dredging reservoirs and dams, can be attributed to wetland degradation. Another method involves looking at damage costs avoided by maintaining functioning wetlands. This includes assessment of the reduction in the lifespan and effectiveness of downstream infrastructure such as dams and reservoirs.

An assessment of damage costs avoided for infrastructure is used in this study to value sediment retention services. It is more realistic using this approach than to assume that preventive or mitigative technologies will be set in place. It also presents a fuller picture of the likely socio-economic benefits of sediment retention services, rather than a minimum estimate of alternative expenditures. The damage costs avoided approach involves calculating the investment and recurrent costs of dam and reservoir construction, establishing a relationship between sediment loads and siltation rates and the lifetime of dams, and calculating the effective costs saved, or dam and reservoir lifetime extended, as a result of wetland sediment retention.

Over half of soil erosion in Africa is transported by water and ends up in aquatic systems (Norese & Saigal 1993). Many southern African rivers have high sediment loads, and it is estimated that 120 million tons of silt end up in South African rivers each year (Turpie & van Zyl in press). Sedimentation of dams results in reduced lifespan and increased dredging costs (Aylward 1998). In southern Africa, high silt loads wear away at power-generating equipment, and have cut the useful life of some dams by 25%, with major dams silting up in less than 20 years, representing a substantial economic cost (Chenje & Johnson 1996, Aylward 1998). However, there is very little literature on the silt loads of the Zambezi River and on the actual silt reduction capacity of the wetlands under study. This study estimated the value of silt load reduction in terms of replacing the live storage assumed lost annually in dams. It is important to note that a component of sedimentation is due to natural, unaccelerated, erosion. Nevertheless it is reasonable to assume that the natural sedimentation rate is already built into the expected lifespan of dams.

5.7.1 The Barotse floodplain

The sediment load of the Zambezi River around Mongu is very low and water clarity is consequently high (Mr Zimba, Dept of Water Affairs, pers. comm.). This could be due to the upstream effects of the Barotse floodplain reducing silt loads before the water reaches Mongu, but it is unknown to what extent they play a role. There are some benefits to maintaining water clarity below the Barotse wetland, especially to the emerging recreational tigerfish fishery, which is healthy and represents significant potential value (S. Coertzen, Tutwa Tourism, pers. comm.) Tigerfish are visual predators, and healthy populations are partially the result of low silt loads. There are no dams between the Barotse wetlands and the "boundary" of consideration for this function, the Chobe-Caprivi wetlands. There is thus no real value assigned to the reservoir protection function for the Barotse wetlands in this study. It should be noted, however, that it is in all likelihood cumulative with the Chobe-Caprivi in reducing silt loads during the peak flood, and although not valued here, contributes to the value of reservoir protection discussed under the Chobe-Caprivi below.

5.7.2 The Chobe-Caprivi wetlands

These wetlands play a sediment reduction role for one major reservoir, Lake Kariba, and two planned major HEP dams, one at Batoka Gorge and the other at Devils Gorge, both between Victoria Falls and lake Kariba (Tapfuma 1995). However, Kariba, which was commissioned in 1959 for the purposes of hydropower generation, has the world's largest reservoir capacity of 180 600 million cubic metres (WCD 1999). It is simply impossible to assume that even high silt loads will have any quantifiable effect on the lifespan of this reservoir of over 550 000 ha in area within the time span that this study considers reasonable for economic projections (20-50 years). The silt load reduction benefits of the Chobe-Caprivi are, however, likely to be realized if the two "smaller" HEP dams are constructed.

The proposed dam at Batoka Gorge has undergone extensive EIA screening and is the most likely of the two proposed dams to get the go ahead in the near future (Tapfuma 1995). High sediment loads will have a negative impact on the lifespan of this proposed long, narrow and deep dam. The total cost of the scheme is estimated at US$1.5 billion with an expected economic life of 50 years. Even if the life of the dam is assumed to be reduced by only 10% through degradation of the Chobe-Caprivi and Barotse wetlands, it would necessitate the building of the Devils Gorge dam 5 years sooner than necessary. This would result in an economic loss of at least US$8.9 million in reduction of electricity generation capacity and capital opportunities forgone (estimated using a 8% discount rate, data from Tapfuma 1995 annualized over 50 years). The benefits of even a moderate silt load reduction function attributed to the Chobe-Caprivi system are thus quite high.

5.7.3 The Lower Shire and the Zambezi Delta

There are no dams, planned or in existence, below the Lower Shire wetlands, either on the Shire River or the main channel Zambezi. There are thus no infrastructure benefits to the silt load reduction function of the Lower Shire and Zambezi Delta wetlands. However, sediment retention helps maintain deep open river channels throughout the year and facilitates transport routes for barges and larger boats. This allows bulk river transport between Marromeu and Chinde, for example, and may play an economic role in the development of local trade such as in sugar removal from the Marromeu region as the new estates come on line. This may have important local economic values in an area with poor road and rail infrastructure that is susceptible to flooding.

5.7.4 Discussion of sediment retention values

Due to the lack of smaller reservoirs on the Zambezi system, the silt load reduction function of wetlands is only significant for the Chobe-Caprivi system, with the other three systems all contributing some lower, non-quantifiable value. High silt loads have the most significant impacts on smaller water storage and irrigation reservoirs, with dams in high erosion areas of South Africa losing 10% of their capacity per decade. The cost of constructing news dams to replace storage capacity lost to siltation in South Africa is estimated at between US$37-72 million annually (Huntley *et al.* 1990). This ecosystem function would thus have a higher value for the wetlands on the Zambezi tributaries such as the Luangwa and Karue Rivers.

An example of impacts on smaller reservoirs comes from the Mau Forest in Kenya, which lies upstream of several hydropower dams. The forest limits silt and sediment loads in various rivers that rise from it. This hydropower reservoir generates 36 kW and has a capacity of 360 million cubic metres. Loss of the forest, which would vastly increase siltation rates, would bring its lifetime down from 100 to 60 years (Emerton 1992). Although not a wetland example, it illustrates that the 5-year loss in lifespan assumed for the Batoka Gorge project is a conservative estimate.

While the current value of the Zambezi River fisheries can be estimated, the effects of increased silt loads on subsistence, recreational and commercial fisheries such as the Kapenta fishery in Lake Kariba, is unknown. The effect on production technique, which one would apply to value the effect of silt load reduction on fisheries, involves collecting data about current fish catches and values, and establishing a relationship between wetland sedimentation, water clarity and downstream fish productivity and catches. No scientific data is available that identifies the linkage between silt loads, fish breeding success for different species, and the effects high loads have on CPUE in the Zambezi system. Estimation of the value of this wetland ecosystem service was thus not carried out for biological production.

5.8 WATER PURIFICATION

All four of the wetlands considered in this study act as sinks for wastewater from major towns and large rural populations, and all perform a water purification function to some degree. Few of the communities living around study site wetlands, either urban or rural, have access either to piped sewage supplies, or to treated water. Even those urban centres that are adjacent to the wetlands, and are covered at least partially by sewage and sanitation facilities, frequently discharge sewage and other untreated urban and commercial wastes directly into the Zambezi River and its tributaries (Masundire 1995). The large size of these rivers implies that they are able to attenuate or "self-purify" pollution in-stream to some extent, but major urban centres occur adjacent to the wetlands themselves. These include Mongu on the edge of the Barotse floodplain, Katima Mulilo upstream of the Chobe-Caprivi Wetlands, Blantyre/ Limbe and Chikwawa above Elephant Marsh, Nsanje on Ndinde Marsh, and Mopeia, Marromeu and Luabo at the top of the Zambezi Delta. Although few large-scale industries discharge directly into wetlands in the study sites, a number of large scale agricultural schemes such as ILLOVO and Nkhate in the Lower Shire dispose of processing wastewater and agrochemicals directly, or with minimal treatment, into the Zambezi system.

Of all the study areas, the Lower Shire wetlands are the most heavily exposed to water pollution. Blantyre is an extremely hilly city, making wastewater treatment difficult and costly. Most of Blantyre/ Limbe's wastewater flows either into one of the five wastewater treatment works, each in its own hydrological catchment, or directly into one of the six major rivers that flow through or around the city. All of the wastewater treatment plants also drain into one of these rivers, namely the Mudi, Likubula, Limbe, Lunzu, Naperi and Luchenza Rivers. These fast-flowing rivers drain off the escarpment, and ultimately all end up in the Lower Shire within 30-50km of receiving heavy waste loads which are beyond their self-purification capacities within the catchment areas (CarlBro Group 1995). The Mudi and Limbe rivers in particular receive excessive industrial pollution discharges and the current heavy metal loads are a cause for serious concern over public health and environmental damage issues (CarlBro Group 1995). The remaining three study areas all receive sewage treatment outflows and direct sewage flows, but none have the same population densities and heavy industry adjacent to them as in the Lower Shire.

The value of the water purification service of wetlands amounts to the cost savings to industry provided by the wetlands through reducing the necessity for point source pollution control and/or the cost savings by the reduction in water purification costs for wetland and downstream users, as well as the cost savings in terms of downstream production that might otherwise have been reduced by pollution. This is not to say that the wetland removes all of the pollutants entering it. Wetlands have variable absorptive capacity, depending on their structure, and it is virtually impossible to make an accurate estimate of this capacity based purely on wetland size. Pollution entering a wetland beyond its absorptive capacity has a negative effect on the wetland and downstream habitats, and thus polluters technically still have to bear the cost of cleaning up pollution generated beyond this threshold. It is highly likely that the pollution entering the Lower Shire wetlands is in excess of the threshold. Two approaches to valuing this service are used here: a replacement cost technique, whereby we assess the cost of replacing wetlands with artificial water treatment plants - a maximum estimate, and a preventative cost technique, whereby the costs of upgrading infrastructure to eliminate existing pollution into the wetlands is considered. The inherent assumption here is that existing pollution is currently taken care of by the wetland. The accuracy of these techniques is severely limited by a lack of information on the absorptive capacity of the wetlands, necessitating the above assumption. This is likely to lead to an overestimate of the value of the natural function in the case of the Lower Shire, but we are confident that the estimates for the remaining wetlands are more accurate.

Using these preventive expenditures and replacement cost approaches to value wetlands water purification requires that major sources of effluent runoff into the study sites are established. Information sources and estimates for the amount of pollution of different types, and for the costs of setting in place purification measures to treat this waste, are given in each section below.

5.8.1 Method 1: Cost of replacing each wetland with artificial activated sludge and chlorination plant

Maximum estimates of the wastewater processing function of the wetlands were made by estimating the cost of replacing each wetland with artificial activated sludge and chlorination plants capable of processing the equivalent in wastewater to a level that needs no further tertiary treatment. Table 5.8.1 shows the capital, operational and maintenance, and amortized capital costs for activated sludge and chlorination plants of two different sizes (Rogers *et al.* 1985). The potential area of "working" wetland required to process the equivalent volume of wastewater to each wastewater plant was estimated using data adapted from Rogers *et al.* (1985) on the processing capacity of artificial wetlands.

Table 5.8.1. Estimated annualised costs for the installation and operation of activated sludge and chlorination plants that clean equivalent volumes of wastewater to artificial wetlands of two different sizes. Data adapted from Rogers *et al.* (1995)

	Wetland 1	**Wetland 2**
"Working" wetland area (ha)	**1.67**	**16.67**
Capacity (m^3 of wastewater/day)	455	4 545
Costs of "equivalent" wastewater treatment		
Capital cost (millions US$)	0.71	1.6
Recurrent costs:		
Labour use (hours/year)	1 600	5 500
Labour cost (per day)	0.125	0.125
Labour (costs per year)	200	687.5
Power use (kWh/year)	173 333	692 600
Power costs (per KWh)	0.1	0.1
Power (costs/year)	17 333	69 260
Chlorine (tonnes/year)	1.5	15.2
Chlorine (per tonne)	300	300
Labour (costs per year)	457	4 566
Parts and supplies (per year)	8 000	16 000
Amortised capital (8% at 20 years)	72 313	162 960
Total annual cost (US$ per year)	98 303	253 474
Per ha annual cost (US$ per year)	58 982	15 208

These data were converted to 1999 prices and wetland specific local prices for labour and power costs were included. The costs of bulk chlorine supply for wastewater treatment were obtained from South African sources as assumed similar in all four wetland areas. Costs were reduced by a factor of four for each order of magnitude jump in working wetland area, up to a maximum of 16 000 ha of wetland, after which it was assumed that benefits of scale remain constant. Table 5.8.2 shows the value of the water purification function of each wetland estimated using the replacement cost method described above.

Table 5.8.2. Estimated annualised costs for the installation and operation of activated sludge and chlorination plants that clean equivalent volumes of wastewater to the wetlands of the study areas. Data adapted from Rogers *et al.* (1995)

	Barotse	Chobe-Caprivi	Lower Shire	Delta
"Working" wetland area (ha)	275 000	50 600	113 400	446 250
Capacity (m^3 of wastewater/day)	75 000 000	13 800 000	30 927 272	121 704 545
Costs				
Labour use (hours/year)	4 528 443	833 233	1 867 365	7 348 428
Labour cost (US$ per hour)	0.19	0.44	0.17	0.13
Labour (US$ per year)	852 413	364 540	312 966	918 554
Power use (kWh/year)	570 254 491	104 926 826	235 152 216	925 367 515
Power costs (US$ per KWh)	0.031	0.033	0.020	0.020
Power (US$ per year)	17 711 434	3 497 561	4 666 261	18 507 350
Chlorine (tonnes/year)	12 531	2 306	5 168	20 335
Chlorine (US$ per tonne)	2 083	2 083	2 095	2 083
Chlorine (US$ per year)	26 107 161	4 803 718	10 825 787	42 364 802
Parts and supplies (US$ per year)	13 173 653	2 423 952	5 432 335	21 377 246
Amortised capital (8% at 20 years)	134 173 653	24 687 952	55 328 335	217 727 246
Approximate total annual cost (US$)	192 000 000	35 800 000	76 600 000	300 900 000

The values estimated using the replacement cost method are exceptionally large and need to be placed in context since they represent nothing more than a maximum theoretical value. The values assume that the volumes of wastewater processing estimated are achieved on a daily basis. For example, it is assumed that the Lower Shire has a daily flow-through of 31 million m^3. Flow records for the Lower Shire indicate annual variations in flow, from less than 1000m^3 per day during dry periods to as much as 80 million m^3 per day in peak floods (Sweco 1982). The annual average figure was not available, but is presumably much lower than the required daily amount of 31 million m^3, if trends in the nearby Zambezi River are used as a comparison (Sweco 1982). The estimated purification value of US$76.6 million for the Lower Shire would thus never be actually realised. Furthermore, some water purification infrastructure already exists in each site, and water-borne pollution is reduced to levels below that which would normally be cycled through a wastewater treatment plant. Since the method assumes values to treat highly polluted wastewater, it is an overestimate when it comes to removing impurities from water that is less than highly polluted.

This method assumes that wetlands remove all the impurities in wastewater, purifying it thoroughly in the same fashion as artificial wetlands designed to do this task. However, artificial wetlands are likely to have a higher cleanup function than natural ones, being specifically modified through vegetation and substrate manipulation to achieve this task, and could be an order of magnitude more effective in waste removal than natural wetlands (A. Batchelor, CSIR, pers. comm.). Thus, due to the limitations of this method and the resultant exceptionally high values estimated, no NPV was calculated using these figures and an alternative method of value estimation was employed.

5.8.2 Method 2: Costs of upgrading existing infrastructure

This method estimates the costs of upgrading existing water purification infrastructure, as well as the costs of investing in new infrastructure, that will allow the release of water of "sufficient quality standards to minimise impacts on human health". The standards applied to each study area are those adopted by the government of Malawi for their new sanitation master plan for the city of Blantyre (CarlBro Group 1995). The mitigation measures required to meet the standards recommended in the Blantyre study include:

- an improvement in sewage and industrial wastewater connections;
- new connections and treatment plants for formal parts of the city;
- latrine construction for informal parts of the city, i.e. squatter areas; and
- latrine construction for informal settlements in the catchment area (CarlBro Group 1995).

To maintain water quality within the wetland areas downstream, this study assumes that the construction of elevated pit latrines for wetland dwelling households will be necessary to replace wetland water purification functions on-site. Information and data on sewered and unsewered populations, industrial runoff, rural and urban population figure for latrines, and their relative construction costs were obtained from various literature sources, including Ashley & LaFranchi (1997), CarlBro Group (1995), CSO (1990), CSR (1994), Mendelsohn & Roberts (1997), Schmidt (1997) and Sweco (1992), and interviews with the town clerks of Mongu, Katima Mulilo, Kasane and Blantyre. The infrastructural requirements and their associated costs for achieving improved water quality are given in Table 5.8.3.

Achieving such standards in each wetland area would imply that the water purification function of wetlands would then no longer be needed. The annual costs of having to mechanically purify water to a level where it is safe for human use downstream can thus be used as a proxy value for the minimum value of the current water purification function of the wetlands in each study area when considering current pollution loads. The NPV of water purification attributed to wetlands for each study area was calculated over 20 years, assuming a 2% population growth rate and an 8% discount rate. The Lower Shire wetlands, despite being smaller than both the Zambezi Delta and the Barotse floodplain, have the highest water purification value. This is a direct consequence of the high proportion of a large population that utilise the wetlands and their catchment area for direct sewage disposal. In fact, the wetland water purification function in the top end of Elephant Marsh is being overextended, with increasing incidence of water-borne disease outbreaks occurring in recent years (Mr Msiska, Blantyre City Engineer, pers. comm.). It is in recognition of this trend, and of the impending health disaster if it continues, that the Ministry of Local Government in Blantyre has commission a phased upgrade of its sewage and wastewater systems. It should be noted that despite the effects on the human population of Elephant Marsh, the same effects are not felt less than 50km downstream in Ndinde Marsh (Mr. Wengawenga, Ministry of Water Development, pers. comm.).

Table 5.8.3. Estimates of the water purification value of the study area wetlands, based on the infrastructural requirements and their associated costs for achieving improved water quality in each area. Data on proportions of populations and industries requiring infrastructure was adapted from CarlBro Group (1995).

	Barotse	Chobe-Caprivi	Lower Shire	Delta
Upstream sewered pop - formal settlement hh	3 812	3 000	17 675	0
Upstream unsewered pop - formal settlement hh	11 436	1 200	12 546	7 654
Formal settlement average hhsize (persons)	4.6	5.4	3.2	4.1
Upstream unsewered pop - informal settlement hh	3 417	280	115 007	30 616
Upstream major-polluting industries	1	1	16	1
Upstream minor-polluting industries	7	26	15	5
Wetlands population (no. hh)	38 656	3 207	57 001	78 290
Cost of sewage treatment plant (US$ per capita)	15	15	15	15
Cost of VIP latrine (US$, annualised)	30	30	30	30
Cost of elevated pit latrine (US$, annualised)	40	40	40	40
Sewage treatment outflows (person equivalents)	1 753	1 620	5 715	0
Industrial waste-load (person equivalents)	275	750	1 975	225
VIP latrines required	683	56	23 001	6 123
Elevated pit latrines required	7 731	641	11 400	15 658
Cost of sewage treatment plant (US$/y)	819 489	132 750	723 830	474 096
Cost of latrines (US$/y)	329 752	27 336	1 146 050	810 016
Total annual costs (US$)	1 149 241	160 086	1 869 880	1 284 112
NPV of wetland water purification (US$)	11 300 000	1 600 000	18 400 000	12 700 000

While the estimates of this indirect use value are high when compared to the value of other indirect uses, they are relatively low when compared to the economic costs of water-borne diseases such as diarrhoea and dysentery and the loss of household livelihood due to contaminated river basins. It should be noted that these estimates are based on current industry and population numbers and should thus be considered minimum values for the water purification function of wetlands. Current development policies of all the countries in this study suggest that urbanisation and industrialisation, and their associated wastes, are likely to increase, increasing the value attached to this wetland ecosystem function over time.

5.9 SHORELINE PROTECTION

The coastal protection services of wetlands can be calculated by using mitigative or preventive expenditures approaches (by looking at the costs of taking action to mitigate or prevent coastal erosion, such as groynes, flood barriers etc.), or by assessing the avoided costs of damage, or avoided effects on production. The second method is a more realistic scenario because it assesses actual values, rather than assuming that preventive or mitigative technologies will be set in place, an unlikely scenario in the highly inaccessable, poor Delta region. The damage costs avoided method also presents a fuller picture of the likely socio-economic benefits of sediment retention services, rather than a minimum estimate of alternative expenditures.

However, calculation of coastal protection services of the Zambezi Delta wetlands using damage costs avoided or effects on production techniques involves complicated data requirements, including:

- assessment of the historical frequency of coastal storms;
- assessment of the severity of such events and their area of impact;
- estimation of the economic damage they give rise to in terms of destroyed agricultural production, commercial production and infrastructure; and,
- estimation of changes in storm damage under different scenarios of wetland status.

None of this data is readily available for any area of Mozambique, let alone the Delta region for which information is particularly scarce. Given the total lack of current infrastructural support in the region, it is also unlikely that storm mitigation infrastructure would ever be set in place. The more likely scenario is that people will simply move in response to shifting coastlines and storm damage patterns. The value of this ecosystem function was therefore not estimated in this study. However, to highlight the potential value of this function, the avertive/ mitigative expenditure values estimated for the Seychelles are given below (from Emerton 1997).

The Island of Mahe in the Seychelles is surrounded by coastal wetlands that buffer storms and thus control beach erosion and damage to coastal infrastructure. Both reefs from the sea direction, and coastal vegetation from the land side, protect against beach erosion. The wetland marsh and mangrove areas around the coastal zone of the Seychelles additionally act as flood and storm barriers. Beach erosion, and increased floods and storms impose a range of economic costs on human settlements and infrastructure as well as to natural habitats and species. The existence of these wetlands means that the mitigative or avertive expenditures of artificial groyne and flood barrier construction, which would be needed to prevent coastal erosion of reclaimed land, does not have to be made. This ecosystem function thus forms a component of the economic value of beach protection, and storm and flood control provided by the presence of terrestrial and marine biological resources. This has an annual quantifiable value of nearly US$1 million for a 13.75 km coastline.

As it can be seen, the value of this ecosystem function can be high. However, benefits transfer is not appropriate in this case as the Mahe socio-economic system is quite different, being highly developed with a valuable tourism industry. Furthermore, the estimated value of beach erosion and storm and flood protection is a bundled value for wetlands and coral reefs.

5.10 CARBON SEQUESTRATION

Pearce (1990) estimated that approximately 100 tons of carbon per hectare is released from a deforested area of tropical land. Ellenbroek (1987) gives a wide range of dry mass standing stock figures for various species of grass, reeds and sedges, ranging from 0.5 to 50 tons per hectare. Jeanes and Baars (1991) give similar dry mass standing stock figures for the Barotse floodplain of between 5 and 40 tons per hectare. None of these two studies give the actual mass of carbon stored however. This study assumes a figure of 5 tons of carbon per hectare.

Pearce 1990 cited a value derived by Norhaus of US$13 for the damage costs due to a ton of carbon released during economic production. The more common method of valuing carbon sequestration is to assume carbon sinks save on the mitigation costs necessary to remove an equivalent amount during economic production. Watson *et al.* (1996) estimated that mitigation costs for carbon releases are in the range of US$0.5 to US$29 per ton of carbon. Most GEF documents dealing with this subject give the range of mitigation costs of US$10-20 per ton of carbon (H.J. Ruitenbeek pers. comm.). This study assumes a cost of US$10 per ton of carbon removed, resulting in a conservative figure of US$50 per hectare for wetland carbon sequestration. Table 5.10.1 shows rough estimates for the NPV of the carbon sequestration function of the wetlands in this study, based upon the extrapolation of US$50/ha to their areas.

Table 5.10.1. Rough estimates of the NPV (US$) of the carbon sequestration function of the four wetlands in this study. Values based upon an average of two tons of carbon removed per hectare per year

	Barotse	Chobe-Caprivi	Lower Shire	Delta
NPV of carbon sequestration	27 million	11 million	8 million	64 million

These values should only be considered as rough estimates and may well be out by an order of magnitude. Furthermore, it is not known to what degree carbon is actually captured and held by the wetlands, which are extremely productive with high vegetation turnover rates. It is possible that, in fact, they actually recycle existing carbon and over time have a negligible effect on net atmospheric carbon removal. The effects of wetland degradation on this function are also unknown, but are likely to be small because ecological changes or agricultural conversion involves the replacement of existing vegetation with other plant communities which also have a carbon sequestration function. Nevertheless, if global trends in climate change management continue, governments may well be able to use such values as mechanisms for the transfer of international funds into wetland conservation and management.

5.11 COMPARATIVE OVERVIEW

A summary of the estimated net present indirect use value generated by ecosystem functions, for each of the four wetlands in this study, is given in Table 5.11.1. Where values were not estimated, the likely importance of the ecosystem function is given a rating of high, medium or low, based upon qualitative information available to the consultants. The values are generally lower than the NPVs reported for direct uses. No accurate data are available that enable an assessment of whether current ecosystem functions are being utilised at sustainable levels or not. Some qualitative indicators do exist. The value for the Lower Shire is estimated for a partially degraded wetland and the benefits from this system would consequently be higher if Elephant Marsh were in better health, resulting in a more favourable current flooding regime. The total lack of groundwater provisioning infrastructure in the Delta would imply that the groundwater recharge function is not being used and the potential to increase the value attributable to this ecosystem service through the provision of well and borehole infrastructure is huge. The increasing health problems in the Lower Shire around Elephant Marsh suggest that the water purification capacity of this marsh has been exceeded, implying that the value estimated for this function may be too high. In light of the lack of accurate data, however, the values estimated in this study assume that current uses of these ecosystem functions are at or below sustainable levels.

Table 5.11.1. The estimated NPV (US$ millions) of indirect uses, or ecosystem functions, of the four wetland areas. Where values were not estimated, the likely importance of the ecosystem function is given a rating of high, medium or low

Ecosystem function	Barotse	Chobe-Caprivi	Lower Shire	Delta
1. Flood attenuation	0.4	Low	2.7	Medium
2. Groundwater recharge and water supply	5.2	0.5	7.5	3.2
3. Sediment retention	Medium	8.9	Low	Medium
4. Water Purification	11.3	1.6	18.4	12.7
5. Shoreline protection	-	-	-	Low
6. Carbon sequestration	27.0	11.0	8.0	64.0
Minimum estimate of total (US$ millions)	43.9	22	36.6	79.9

With the exception of the water purification function, populations affected by ecosystem services are assumed to remain constant over 20 years in NPV calculations. This assumption is fairly robust for all the remaining ecosystem functions valued. Increasing wetland population densities do not always imply a corresponding increase in the total area of fields planted or the total herd size in the wetland area. Often, the amount of area planted or number of cattle owned per household will decrease with increasing population growth since all the best arable land is already planted and the wetlands are stocked at close to maximum carrying capacity. Furthermore, the number of boreholes and wells is relatively independent of population densities across our study areas, ranging from 97 to 2 200 people per borehole or well in the Chobe-Caprivi and Delta wetlands respectively. Road and rail infrastructure is also likely to be unaffected by population growth in the short term. Initial sensitivity analyses indicate that increasing population growth will affect NPV by no more than 1-2%.

In comparison to these estimates, Costanza *et al*. (1997) attribute a major portion of the total value of wetlands to ecosystem services such as flood regulation and waste treatment (Table 5.11.2), compared with relatively small values for the harvest of resources. Their estimates are based on the available literature for wetlands world-wide (Costanza *et al*. 1997, R. Costanza, pers. comm.).

The estimates of Costanza *et al.* (1997) are two to three orders of magnitude above those estimated in this study. This can be explained by several factors. Generally, they are estimates made from small, highly-utilised wetlands in western countries. Estimation methods used are usually changes in productivity methods based on a thorough understanding of the wetland functioning and mechanism of contribution to the human economy that surrounds it. Data for events such as floods, or physical characteristics such as groundwater infiltration rates relative to flood and rainfall levels, are well documented. They are also bundles of value estimates, including the value of storm protection and water supply to reservoirs which add value. Furthermore, most of these wetlands are utilised by highly developed societies where events such as floods cause high dollar value damage to formal economic activities. By comparison, the data paucity of the study areas has been well expounded upon and the huge size of the study area wetlands, with vast portions often remaining only lightly utilised by subsistence economies makes such a per hectare comparison with the literature worthless. Nevertheless, the potential magnitude of these wetland ecosystem services is large when large populations of formal economies derive benefits from them.

Table 5.11.2. Indirect use values (US$/ha/year) estimated by Costanza *et al.* (1997) for global wetlands on average, and values estimated in this study.

	Costanza *et al.* (1997)	Zambezi Wetlands
Flood & water regulation, & storm protection	7 240[1]	4[2]
Groundwater recharge and water supply	7 600[3]	6
Waste treatment	1 659	20

[1]includes value of storm protection
[2]Zambezi wetlands estimate for flood attenuation only
[3]include the value of reservoir suuply

A more recent study by Acharya & Barbier (in press) of rural groundwater use by subsistence agriculturalists in the Hadejia-Nguru wetlands in Nigeria valued the groundwater recharge function of the wetland at US$62/ha under current levels of agricultural use. This study used a production function approach, estimating the loss in welfare that would result from a reduction in the water table if flooded areas were reduced. The hydrological relationship between recharge rate and flooded area was known. This estimate is for a highly cultivated part of the wetland and uses a sophisticated data-intensive method, and gives a value closer to the US$6/ha found by this study than the US$7 600/ha found by Costanza *et al.* (1997).

The point that these estimated should be considered as minimum estimates has been made several times and is reiterated here. The limitations on data resulted in the use of simplistic methods that inherently tend to provide low-end estimates. The preferred data-intensive changes in productivity techniques would tend to provide higher estimates of value. However, the true values to local economies of some of the ecosystem services have not been estimated due to lack of dose-response and physical relationship information, or data on numbers. For example, the real benefits of water purification and groundwater recharge and water supply tend to be in the human health effects that such wetland functions facilitate. Pegram *et. al.* (1998) state that inadequate water supply and poor sanitation are responsible for the high levels of diarrhoeal disease in developing countries. They estimate that in South Africa, the annual costs attributable to such disease is in the region of US$540 million, and that such costs can be reduced by up to 50% through the provision of access to safe water and increased sanitation. The real benefits of these ecosystem services are thus much greater than the estimated cost of their replacement or the costs of mitigating human impacts in the absence of their natural functions. The mitigation measures that the city of Blantyre is only now considering, and the costs of such measures, do not reflect the same level of value as all the pervasive health benefits from the clean water provision of the Lower Shire wetlands over the past 100 years or more.

A cautionary statement that should be made is that one cannot make generalisations very easily from other systems when trying to estimate indirect use values. Even within the Zambezi Basin, where one would assume it safe to make such generalisations, one finds that each wetland system is unique hydrologically, depending on underlying geology and geomorphology, soil types and permeability and the nature and extent of underlying aquifers. Each system is also unique biologically and socio-economically. Extrapolating literature-based trends and benefits transfer of economic values such as the ones estimated by Costanza *et al.* (1997) above is strongly advised against.

It is also important to realise here that not all the values presented or discussed in this study are additive. Indeed, some are directly contradictory and represent trade-offs to one another. In particular, the value of agricultural production within the wetland incurs loss of wetland habitat. This may impose a cost in terms of grazing area lost or a loss of fishery productivity. Similarly, traditional fisheries may conflict with angling tourism, and burning for grazing or excessive reed harvesting may impose costs on bird populations, and hence bird harvesting and bird tourism. Agricultural projects may impose cultural costs as well as other costs such as nutrient pollution. Almost all direct uses of a functioning ecosystem will conflict in some way with the processes that are naturally maintained under non-impacted conditions. The nature of such impacts and the likely implications to indirect use values are discussed in Chapter 7.

6 EXISTENCE AND OPTION VALUE

6.1 INTRODUCTION

The issue of the valuation of benefits from ecosystems has received considerable attention, particularly in recent years. However, the most complex form of benefits to measure are those that do not arise from ecosystem use, be it direct or indirect, but rather from the fact that people know that complex, functioning ecosystems exist, and derive utility from that knowledge. Such benefits are not necessarily attached to goods that may be bought or sold in the market place, but rather take on intangible forms. Benefits from the existence of a natural resource or ecosystem may include satisfaction in the diversity of life, the belief in a sense of place, feelings of custodianship and the knowledge that perhaps our descendants may wish to use the resources in question in the future. Despite being intangible and unpriced in conventional markets, people are willing to pay to enjoy such benefits, as is evidenced by the numerous donations made to conservation agencies world wide each year. Non-market valuation techniques which elicit people's willingness to pay (WTP) through various survey techniques are used to value such benefits. The goal of this study was to estimate the non-use value of biodiversity conservation in the Zambezi Basin wetlands through the use of open-ended Contingent Valuation surveys.

Due to logistical difficulties and budget limitations, this goal had to be limited to a case study of only one of the ZBWCRUP study areas: the Barotse wetland. The non-use or existence value of wetlands in Zambia was measured using the Contingent Valuation Method (CVM) through the administration of a survey questionnaire. The main aim of the CVM questionnaire survey was to ascertain Zambians' willingness to pay (WTP) for the conservation of biodiversity in the Barotse wetland.

6.2 METHODOLOGY

The questionnaire was composed of a combination of open-ended and referendum-format questions and was designed for face-to-face interviews, which are considered preferable to telephonic or postal surveys (Arrow *et al.* 1992).

Although CVM uses a hypothetical approach, the questionnaire aimed to be as honest and straightforward as possible. Potential respondents were greeted with the following:

> Hello. We are working through an international group under the IUCN. We are carrying out a survey on people's knowledge and opinions on the wetlands of the Zambezi River. This questionnaire does take quite a while, maybe ten or 15 minutes, but your opinion is valuable to us. We are trying to establish how much it matters to Zambians to what extent the wetlands and their animals and plants are conserved or transformed to other uses like farming. All your answers are confidential. There are no specific answers that we are looking for, so please just tell us exactly what you think.

The questionnaire starts off by questioning the respondent on general issues in Zambia, partly as an ice-breaker, and to get the respondent into a mode of thinking about his/her answers. They were asked their opinions as to how serious the following problems are in Zambia: population growth, unemployment, bad infrastructure, quality of education, drought, health services, cultural changes and environmental degradation.

It was important to set the study area in an appropriate context for the respondent. If the questions had centred only on the Barotse wetland, the respondent would be likely to express a disproportionately high willingness to pay relative to the importance of the area in his/her overall perception. The first questions were thus used to set a broad wetland conservation context, and were designed to make the respondents think about their attitude to conservation, their available budget and the total amount they would be willing to pay towards wetland conservation for the *whole* of Zambia. This is important for minimising 'embedding bias' (Willis & Garrod 1991, Pearce & Moran 1994), since by forcing the respondent to consider the limits to, and other demands on, his or her budget, the respondent would be less likely to place undue WTP on the resource in question simply because it was the subject of our survey. Respondents asked the following:

> Do you think the conservation of nature in Zambia is important?
>
> Zambia's natural areas consist of forests, savanna woodlands, and wetlands and rivers. Although all these different areas may all be equally important to you, or some may be more important than others, we just want to ask you about wetlands. As you know, Zambia has a large area of wetlands (respondents are shown a map). Does it matter to you whether these wetlands exist in their natural state?
>
> How much of these wetland areas do you think should be conserved in a natural state - all, most, half, little, or none?
>
> If some wetlands were threatened with destruction, would you be willing to give anything (money or whatever) to help ensure that the amount of wetlands you would like to see conserved would remain conserved?

If respondents answered in the affirmative, they were presented with the following hypothetical scenario, after which their willingness to pay was ascertained:

> Because the number of people in Zambia is growing all the time, the government must consider development possibilities that affect natural areas, including these wetlands. It is possible that part, or even all, of these wetland areas will be developed, for example, for agriculture. If this is done, the wetlands will be changed or will disappear. This means that there will be no more place for the animals and plants that live in those wetlands. These include the animals and plants that people use for food and building, some that aren't used by people except to enjoy seeing them, and others that are important for spiritual reasons. Maybe some aren't important now, but could be important to your children's children for some reason.
>
> Suppose that the government decided to sell development rights for all the wetland areas in Zambia, on a per unit area basis. The aim of this would be to allow private companies to convert the wetland areas for cash crops such as rice. Suppose that Zambian National Parks and Wildlife Services or the World Wide Fund for Nature (WWF) or another conservation agency, is also allowed to purchase the land rights for some of this area, in order to prevent its conversion and maintain it in its current state. This means that normal uses of the wetland in those areas would continue as at present, without allowing further degradation or loss of an area. This agency would have to rely on public donations to make a bid for these land rights, and the amount that they bid for will thus depend on how much money they can raise from everybody in Zambia.
>
> Would you be willing to donate to this conservation agency, as a once-off payment, to enable them to get sufficient funds to bid for wetland rights?
>
> If yes, how much - but before you answer this question, please think about (a) how much money you have to spend on everything, like household expenses, entertainment, etc, and (b) how much money you are willing to donate to conservation in general, before you decide how much you would want to

donate towards the conservation of wetlands. But also remember that this is just a one time payment, and next year you may prefer to spend your money on conservation of something else.

Respondents were then asked to apportion the money among the different wetlands, after which they were asked about their knowledge of the existence of the Barotse wetland.

Let's look at the map again. How would you like to split your donation between these four wetland areas: Barotse, Luangwa, Kafue and Bangweula?

Do you already know of, or have you heard of the wetlands in Barotseland in Zambia's Western Province?

Have you ever seen this wetland?

Because of the difficulties of administering a CVM questionnaire to rural households, due to low literacy, low income and unwillingness to consider hypothetical questions, the questionnaire was designed for those working, urban Zambians defined by the national government as part of the Formal Employment Sector (CSO 1998). It is thus designed to capture the higher values of a relatively minority group, and produces a minimum estimate of non-use value. It is assumed that the willingness to pay by rural or unemployed Zambians would be low or negligible in many cases. In total, 300 questionnaire interviews were randomly administered in and around Lusaka by students from the University of Zambia. The entire questionnaire took between 10 and 20 minutes to administer.

6.3 RESULTS

The respondents' answers to the initial framing section are given below in Table 6.3.1. It is common practice to make the first set of questions 'throw-away' items to let the interviewer/interviewee settle into a routine. Studies show that the first questions usually show the highest level of unreliability, so it is important not to ask any questions that are important, or that are difficult to interpret until a few minutes into the process (H.J. Ruitenbeek pers. comm.). Thus, while perhaps interesting, no further analysis was conducted on these answers.

Almost all respondents (99%) think that conservation of nature in Zambia is important, and 91% state that it matters to them that some wetlands in Zambia exist in their natural state. Most respondents felt that at least half of the wetland area in Zambia should be conserved in a natural state (Fig. 6.3.1).

Table 6.3.1. Percentage of respondents that ranked general problem issues in Zambia as very important (1), quite important (2) or not important (3)

	Percentage responses in each rank		
	1	2	3
Population	55	31	13
Unemployment	88	10	2
Bad Infrastructure	62	34	4
Education	76	19	5
Drought	30	48	21
Health	77	19	4
Culture	14	49	36
Environmental degradation	53	39	8

In response to the question of whether the respondent would be willing to give some help, of whatever nature, towards ensuring the conservation of the amount of wetland stated in their answer to the previous question, 85% of respondents stated that they were willing to contribute towards such wetland conservation.

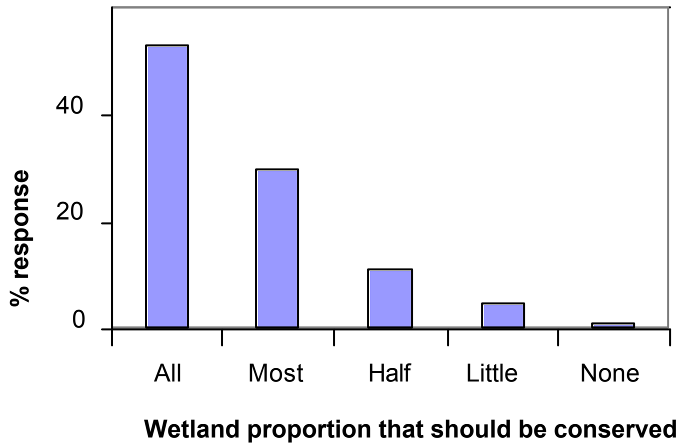


Figure 6.3.1. Percentage of respondents who stated that all, most, half, a little or none of the major wetland areas in Zambia should be conserved in a natural state

At this point, the hypothetical scenario mentioned above was presented. In response to the direct question of whether they would be willing to make a donation to a conservation agency in order to help them acquire sufficient funds to bid for wetland rights, 80% of respondents stated that they were willing to donate something.

Where respondents stated a zero bid for WTP, it was included in the analysis. Where respondents stated that they would be willing to pay, but failed to make a bid, the field was left blank in the analysis. The average bid per respondent, including zero bids, was ZK74 494 (US$35.06) donated towards acquiring conservation rights for all major Zambian wetlands. Respondents, on average, apportioned their bid roughly equally to the four major Zambian wetland areas (Fig. 6.3.2).

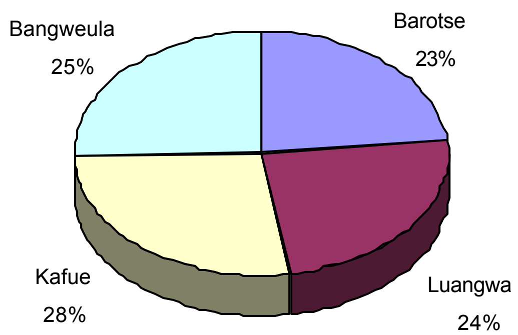


Figure 6.3.2. Percentage of the total existence value for all major Zambian wetlands apportioned by respondents to individual wetlands.

An average bid of ZK18 921 (US$8.90) was received for conservation rights over the Barotse wetlands specifically (n=296). The average bids for all wetlands and the Barotse wetland were extrapolated to the 475 000 Zambians officially estimated to be formally employed, which is approximately 5% of the total population and 10% of the total labour force (CSO 1997, CSO 1998). Table 6.3.2 shows the values derived when the average bids are extrapolated to the formally employed population sub-sampled. The WTP estimate in each case represents the Net Present Value (NPV) for the conservation and wise use of wetlands in Zambia and the Barotse wetland since, according to the scenario bid upon, it is a one-time payment to secure the conservation and wise use of the wetlands to perpetuity.

Table 6.3.2. The size of the Zambian population, total labour force and the number of people in formal employment, and the estimated WTP (US$) of the formal employment sector of Zambia for the conservation of the major Zambian wetlands in total, and for the conservation of the Barotse wetland specifically. WTP in these cases represents the Net Present Value (NPV) of existence and option value.

Zambian Population	Total Labour Force	Formal Employment	WTP for Zambian Wetlands (US$)	WTP for Barotse Wetlands (US$)
9 281 895[1]	4 194 895[2]	475 000[3]	16 651 506	4 229 309

[1]In 1996 (CSO 1997), [2]in 1997 (CSO 1998), [3]in 1996 (CSO 1998)

The population sampled is educated and working, and this study thus assumes that respondents are aware of the opportunity cost of capital or their time preferences and implicitly incorporate their perception of discount rate into their bid. To obtain the annual value for the Barotse wetland, one cannot, therefore, simply divided the total WTP by the time horizon of 20 years selected for analysis by this study. One needs to annualise the bid and increase its annual value until the NPV under the private discount rate (8% in this study) equals US$4 229 307. The annual WTP for the wise use and conservation of the Barotse wetlands is thus US$430 764.

In total, 91% of respondents knew of, or had heard about, the Barotse wetlands. A further 83% of all respondents had seen it personally or on television or in pictures. There was no significant difference in the WTP of respondents who had and had not seen the Barotse wetland (unpaired t-test, t=0.542, 294 df).

6.4 DISCUSSION OF NON-USE VALUES

It is important to be clear about what the value estimated by this study actually is. A careful inspection of the scenario implies that the non-use value estimated represents people's preferences for maintaining the biodiversity, cultural integrity and current use status of the wetland intact. The phrasing of the scenario (see above) implies that rural people are already utilising the wetland, and that through conservation and management to ensure wise use rather than allowing current patterns of degradation to continue, wetland biodiversity will be maintained. The non-use value estimated is thus a value for the conservation and wise use of wetlands, and not for exclusive protection. It also includes an element of option value since preferences for conservation often arise from the desire to conserve the resource for future potential uses. Such wise use management practices are currently promoted internationally by Wetlands International, IUCN and other major conservation agencies, and this study implies that such a policy does have a value to all people irrespective of use.

The estimated value of US$4 229 000 for the Net Present Value (NPV) of the Barotse wetlands is relatively low compared to the NPVs of the direct and indirect uses values estimated for the same wetland (see chapters four and five). This represents a NPV of US$7.69 per hectare for the 550 000 ha wetland. These values are minimum estimates of existence and option value to Zambian nationals since only those nationals formally employed (5% of the population) were included in the sample. While almost 50% of the population are considered as part of the labour force, the majority of this figure comprises rural subsistence agriculture and informal sector business. A separate instrument with an alternative scenario and payment vehicle would have to be developed to sample this population. While the average bid from this population is likely to be extremely low, the large numbers of people would probably add significant additional non-use value to the already estimated US$4 million.

Another aspect that may contribute to the estimated value being biased downwards is the occurrence of zero bids in the survey. Of the 85% of respondents who initially had indicated that they would be willing to donate towards conserving some of Zambia's wetlands, 25% offered a bid of zero after the scenario was explained. Only 1% of the respondents who initially had indicated that they would be willing to donate towards conserving some of Zambia's wetlands refused to bid. There could be several reasons for these zero bids, including a lack of income, regarding the improvement in the scenario as unimportant, and having a preference for spending money on other goods and services (Spash *et al.* 1998). Given the fact that only formally employed people where surveyed, it is unlikely that zero bids represent inability to pay due to income constraints.

There are another a set of reasons which constitute bias, often against an aspect of the WTP instrument. "Free riders", or respondents who believe that the improvement will go ahead and that they therefore can gain the benefits without contributing, may bid zero. Secondly, respondents may feel paying is an inadequate solution and they therefore refuse to give a WTP bid. Third is a lack of faith in the proposed institution, which can be seen as just a way of raising money which will go into an organisation or individual's pocket and never be spent on the actual project proposed (Spash *et al.* 1998). Distrust of this sort is common in many southern African countries. The final reason under this general set of bias problems is the rejection of the payment mechanism. For example, Spash *et al.* (1998) registered a strong protest of this nature when valuing the biodiversity benefits of a Marine Park in Curaçao where many respondents stated reasons showing a general feeling that financing the Marine Park should be a government responsibility. However, no analysis of the reasons for zero or refused bids was included in the instrument and the zero bids were included in the analysis. The value estimate must therefore be considered as a minimum estimate of non-use value.

Ruitenbeek (1991) estimated an *annual* value of US$15 per hectare ascribed to the biodiversity benefit of maintaining 300 000 hectares of mangrove wetlands in Bituni Bay, Indonesia. This equates to a NPV of US$147.27 per hectare, which is an order of magnitude greater than the value found by this study (discount rate =8%). However, this value represents the "capturable biodiversity benefit" which Indonesia might be able to obtain from the international community through additional aid flows and other international transfers for conservation projects, and not a value to Indonesian nationals for wetland biodiversity conservation. Such international values may also be high for the Zambezi Basin wetlands. For example, US$454 000 was paid to Zambia in a debt-for-nature swap in 1989 to ensure the conservation of relatively small areas of the Kafue Flats and the Bangweula swamps (Pearce 1993). Furthermore, this project, administered by the IUCN, represents at least US$5.2 million in international transfers for conservation projects in the Zambezi Basin wetlands, roughly a fifth of which will go to the Barotse wetland (Hiscock *et al.* 1996).

This study in a sense also measures the "capturable" benefits of biodiversity since it elicits WTP for the conservation of biodiversity, rather than trying to estimate a value for some esoteric notion of biodiversity. By giving respondents an opportunity to value benefits that are tangible, i.e. biodiversity conserved through wise-use management into perpetuity, the value derived is more likely to be realistic and recoverable. The payment vehicle of making a donation is a common method for eliciting conservation funds from the public in southern Africa and bids are in reality probably quite recoverable by conservation agencies.

In any WTP exercise, it is very important to remind the respondents that they are facing a fixed income constraint and that by buying into something like conservation, they may need to give something else up (see NOAA Panel guidelines on this, Arrow *et al.* 1992). The scenario is phrased in such a way that people are forced to consider their donation towards wetlands conservation relative to the conservation of other ecosystems, and relative to their daily expenditures. The scenario thus provides people some standard with which to measure the worth of non-use benefits against the value of other commodities in their lives. This contributes to the notion that such non-use values are real and positive.

The fact that the 83% of respondents who had seen the Barotse wetlands had a WTP of US$1.61 lower than the 17% who had not seen them is somewhat counterintuitive, even if it is not significant. One would expect the opposite: a significantly higher bid from respondents who had seen the system and whose bid might be biased by option values, or the knowledge that they may in fact visit the system again in the future. This seems to indicate minimal bias from option values, or that those who had been to the Barotse wetlands previously placed a lower value on the option of returning than the option value of those who had never been. Alternatively, those who know the system might be aware of its degraded status and heavy human utilisation. These respondents may be hedging their bets by placing a higher proportion of value on the other wetlands, or lowering their bid in response to what they consider as a lower conservation value from the Barotse wetland.

Whatever the reasons, the lower value for those who know the system is somewhat worrying for conservationists. One common method of raising the non-use value attached to a particular ecosystem or resource is to raise public awareness about it. It is an inherent methodological axiom in economic valuation that monetary values are only measurable against human economic activity. If people have no knowledge of a good, it theoretically has no measurable economic value to them. Conservation and activist agencies have used this tactic successfully throughout the world to try and generate values within various sectors of society in order to use such values to justify certain causes. If conservationists wish to raise the existence value of the Barotse wetlands within Zambia, the usual method of doing so would be to raise awareness of the system through the media. Our results indicate that this may in fact lead to reduced values unless carefully handled. There may also be some ethnic biases acting on the bids to cause such discrepancies. Since the Barotse wetlands fall within the essentially Lozi dominated section of Western Province formally known as Barotseland, this may be the result of feelings of political independence and resistance to government control over natural resources in the Province. Our enumerators noticed qualitative differences in Lozi peoples' responses to the questionnaire, but were unable to quantify such responses since tribal differentiation was not specifically included in the instrument.

This valuation exercise is specific to the Zambian and Barotse wetlands and it is not possible to extrapolate these results to other wetlands. This has much to do with the design of the instrument which asked respondents to express a value for a specific ecosystem type within their national boundary, and then to apportion that value to various wetlands within the same boundary. Criteria used by respondents to derive a value, and then make such an apportionment, would be country specific, dependent on the prevailing political system, societal welfare levels and the perceived general and wetland conservation requirements of their country. Furthermore, the generally accepted guidelines for CVM state that benefits transfer for CVM values are not acceptable, primarily for the reasons given above (Arrow *et al.* 1992). However, the non-use values derived in this study gives an idea of the order of magnitude of non-use values relative to other wetland values that is likely to apply to the other wetlands within the ZBWCRUP study.

7 ECONOMIC CONSEQUENCES OF DIFFERENT WETLAND MANAGEMENT SCENARIOS

7.1 INTRODUCTION

Having calculated the current values of the four wetlands, this chapter is concerned with what will happen to those values over time, under alternative management scenarios. This and the following chapter focus on the links between economic structure and policies, wetland management and economic values. Here we aim to demonstrate the economic issues and trade-offs involved in wetland management by assessing the economic impacts of different wetland management scenarios, and attempt to find the optimal broad management scenario, from an economic perspective. We discuss the proximate and underlying economic causes of the present degraded state of the wetlands, and identify some of the conditions that would be necessary to maximise their future value.

We consider four types of wetland management, as being the most realistic options for future development within the Zambezi Basin wetlands. These are combined in various ways to produce management scenarios, as described below.

7.1.1 Wetland management options

7.1.1.1 Maintenance of *status quo*

This option involves taking no major actions either to conserve wetlands or to develop and alter significantly their land use and hydrology. It represents a situation where existing local utilisation of wetland resources continues to rise, and wetland areas continue to be given over to small-scale cultivation, in line with population growth. In practice, this scenario applies throughout much of the Zambezi Basin wetlands under current forms of management and levels of use.

7.1.1.2 Wise use and management

This option would involve setting in place measures to conserve the Zambezi Basin wetlands, to utilise them sustainably, and to share their benefits equitably. This would be likely to involve some level of restrictions on wetland resource utilisation activities – those which are, or become, unsustainable. Sustainable, consumptive and non-consumptive, resource utilisation activities would be continued, and possibly further developed. It would also probably involve efforts to engage adjacent communities much more in wetlands management, and to set in place a range of rural development activities aiming to strengthen local livelihoods and to decrease local reliance on wetlands products. In practice, this scenario currently applies to the parts of the Zambezi Basin wetlands where ZBWCRUP operates.

7.1.1.3 Strict protection

This option would involve gazetting large parts of the Zambezi Basin wetlands as strict protected areas. This means curtailment of all current forms of extractive use, such as fishing, grazing, cultivation, and the harvesting of wild plants and animals, and may also involve restricting non-consumptive utilisation activities, such as research and tourism. It would also probably entail some level of human resettlement to buffer zones outside the protected areas' boundaries. In practice, only one of the wetlands currently incorporates a protected area - the Marromeu Buffalo Reserve in the Delta.

7.1.1.4 Agricultural conversion

This option involves converting large parts of the Zambezi Basin wetlands to commercial or large-scale agriculture as their next most likely alternative land use, such as sugar cane or rice. In practice, this scenario currently applies to various parts of the Zambezi Basin wetlands, including the ILLOVO sugar estate in Malawi, and the Sena Sugar estate which is being rehabilitated in the Delta.

7.1.2 Management scenarios

These alternative management options cannot be applied at the same time in the same area. For example, it is impossible to convert a part of a wetland to rice and simultaneously put it under strict protection. However, the first four at least can be combined within a single wetland by zoning different parts of the wetland for different purposes. An infinite number of scenarios could be considered which combine the options listed above in various ways, but we limit the analysis to a few simple scenarios. We do not attempt to consider the full economic implications of external management issues, such as river basin hydrological management, but these are discussed separately below.

7.2 METHODS

Because of the complexity of the methods involved, and because of the ecological similarities of the four wetlands, apart from the coastal systems in the Delta, a single generic model was used for the quantitative aspects of the scenario analysis, based on the Barotse wetland system. However, the results are discussed in terms of all four wetlands. All results are presented in terms of the value generated over the next twenty years, as a net present value figure. This is a normal economic planning horizon, but an ecological planning horizon would be longer.

7.2.1 Calculation of wetland net present value

The net present value of the wetland is the discounted sum of the net benefits accruing from the present year (1999) to twenty years into the future (2019). Discount rates vary from study to study, and higher discount rates are normally applied in developing countries than developed countries. We apply a discount rate of 8%, the usual rate applied in southern Africa. This is midway between a 4% discount rate, which would be perhaps a more acceptable *social* discount rate, giving greater weight to future benefit streams, and a 12% discount rate, one often applied to developing countries, which is closer to the *private* discount rate, and places much greater emphasis on present values than future ones. Net present value can be estimated in a number of ways:

1. based on a simple projection of present net benefits
2. based on a stream of present net benefits in which future values are altered from the current values along the lines of feasible or expected growth or declines in value.

3. using dynamic ecological economic models to predict the change in the resource base and hence the change in the benefit streams yielded by different resources. This takes ecological linkages between different resources into account.

We present the results of all three types of approaches, but concentrate on the third approach. This approach is complex, and described in more detail below.

7.2.2 The dynamic ecological-economic wetland model

Only some aspects of the scenario analysis could be carried out in quantitative terms, due to data availability, and the remaining aspects are described qualitatively. Quantitative analyses are made with the aid of a simple dynamic ecological-economic model which simulates a simple wetland system and the effects of human activity on that system. It is important to note that the conclusions drawn in this section are made on the basis of stated harvests and trends coupled with a generalised ecosystem model based on limited ecological data, and that ideally the status of resource stocks needs to be ground-truthed with detailed ecological studies. Our estimates should thus be considered as only rough estimates which serve to illustrate a point and should not be taken as exact predictions of resource stock trends and income.

A generic Zambezi wetland model was developed using the modelling software, STELLA, and the generic model was then adapted to model the Barotse wetland area. STELLA is particularly well suited for systems modelling, explicitly showing the interlinkages between components of the ecosystem, and being designed for simulating dynamic ecosystem and economic processes. The model was run over the time frame from 30 years before present (1969) to 20 years hence (2009), in order to simulate past resource trends recorded in this study and to investigate how these trends would affect future income from these resources. The wetland model was set up in such a way as to reach current levels of population, cattle herd size, cropping area and resource utilisation as found in 1999 in year 30 of the simulation. Sensitivity analysis was use to test the degree to which assumptions were robust.

Because of the paucity of ecological data, the model relies to some extent on the general literature on productivity of wetland resources, using existing information from tropical African wetlands as far as possible. Where even this type of data was lacking, certain assumptions had to be made, based on the ecological experience of the consulting team as well as other expert advice. The model has the following sectors:

- Wetland structure

This defines the area of each habitat type within the wetland, taking agricultural cultivation into account.

- Population sector

This defines the population of the study area, and the number of households. Current population growth rates are used. This sector also defines the demands for different wetland resources used by an average wetland household, and where applicable, changing demand in response to other factors (e.g. wealth) are incorporated. Initial population is set to reach current population estimates in year 1999 of the model.

- Fisheries sector

Fish stocks were assumed to follow a normal population growth curve constrained by carrying capacity. The carrying capacity of the wetland was defined as 150 - 200 kg per ha, using the total regularly-flooded area (channels, reedbeds, and wet grass habitats). The generalised production: biomass ratio was assumed to be 1.0, as a typical minimum value for tropical wetland fish species (Marshal & Maes 1994). Fish harvesting is regulated by changing catch per unit effort: in other words, households are modelled to catch fewer fish as the effort required to catch them increases when stocks decline.

- Wild animals sector

In most cases a variety of animals was hunted by wetland populations, which made modelling of this sector particularly difficult. In the case of birds, populations were modelled along the lines of a generic large wading bird species (egret/heron). For other animals, we did not attempt any population modelling, and it had to be assumed that the current harvest could be maintained, but that this harvest would be spread more thinly among households as the latter increased in number.

- Palm sector

Annual palm wood production was taken as 2% of standing stock. Palm fronds are simplistically assumed to regenerate annually and availability is only affected by the density of palms *per se*.

- Reeds & papyrus

Annual reed and papyrus production was taken as 85 tons per ha, based on reported maximum annual productivity of 70 tons for reeds and 100 tons for papyrus (Finlayson & Moser 1991). Reed and papyrus stocks are separated into shoots, harvestable reeds, and senescent stocks. Burning does not affect the annual productivity in the model, except inasmuch as burnt areas revert to production of new shoots rather than growth of the previous year's shoots into mature stems. Burning affects the available harvest. The model incorporates a response to reduced availability, with demand dropping as the effort required to meet needs increases beyond a certain point.

- Floodplain grassland

The annual production of floodplain grasses was set at 10 tons per ha. Usually, about one tenth of this production is in the form of suitable grasses for harvest. Cattle graze different grass species to those harvested, except after burning when the grazing of shoots is less selective. Again, burning affects the available harvest, but only to a certain extent, as most people attempt to meet their harvesting needs before the main burning takes place. As for reeds and papyrus, the model incorporates a response to reduced availability, with demand dropping as the effort required to meet needs increases beyond a certain point.

- Cattle and crop sectors

The model uses the current average area cultivated per household, as an invariable factor. The underlying assumption is that households already cultivate the maximum area they can manage given the amount of labour available in the household, in order to meet their needs. The cattle herd in each wetland is modelled as a growing population, in which growth is slowed as it approaches carrying capacity. Thus as population increases, the number of cattle does not increase in the same exponential fashion, but cattle numbers per household tend to drop off in time. Intrinsic growth rate is taken from Mwafilurwa & Moll (1997) and offtake levels are taken from the survey data. The initial population is set to reach current estimated population size in 1999.

- Financial and economic value sectors

These sectors apply the average net financial and economic values gained per unit of production as found in the static analysis. The financial sector concentrates on the value of the wetland to rural wetland-associated households, while the economic sector gives the value of the wetland to the national economy. Financial and economic net present values are calculated from the present year to

2019, using a discount rate of 8%. Sensitivity analysis of NPV is carried out using discount rates of 4% and 12%.

7.3 WETLAND MANAGEMENT SCENARIO ANALYSIS

7.3.1 Do nothing scenario

The first scenario attempts to estimate the net present value of the Barotse wetland under continuation of present conditions. Based on the findings of the static economic models (Chapter 4), the net present use value of the wetland, in economic terms, could be calculated as US$82 million (time horizon 20 years, discount rate of 8%). However, such a calculation implicitly assumes a constant income from all resources and a constant population in the study area. Table 7.3.1 shows what would happen if the sustainability assumption is relaxed in a simplistic fashion. This assumes that, due to increased pressure on resources caused by population growth, total harvests decrease at some assumed rates. It also assumes that increased price due to scarcity is matched by increase costs, due to decreasing catch or harvest per unit effort. The results in Table 7.3.1 serve to illustrate a point only. This is that unsustainable income from resource use, due to overexploitation of stocks, has an important effect on wetland value, and that this effect is pronounced even with a relatively minor degree of decline in values.

Table 7.3.1. The possible impact of declining resource values on the value of Barotse wetland.

Resource	Rate of decline in value (%) Best case scenario	Intermediate scenario	Poor scenario	Worst case scenario
Cattle	0	0	0	0
Crops	0	0	0	0
Fish	0	1	3	6
Animals	0	1	3	5
Palms	0	1	2	3
Reeds & papyrus	0	0	2	2
Grass	0	0	1	2
Clay	0	0	0	0
Net Present Value ($ millions)	82	57.2	54.2	50.6

However, because populations are increasing, the amount of resources harvested is also likely to increase in most instances, which will give rise to increasing use value of resources, until the harvest per unit effort starts to reduce average take per household. The dynamic ecological-economic model of the Barotse system takes population growth and the effects of resource availability on harvest into account. According to this model, if current conditions are maintained, the NPV, in economic terms, of the wetland is in the region of $64.4 million. The analysis of this scenario is described in more detail below.

This study found evidence for the decrease in stocks or availability of a number of natural resources in all four study areas. Controls on the use of natural resources appear to be weak throughout, with regulations being flouted even where they exist. Pressure on natural resources is likely to increase as populations increase in future. However, it is unlikely that this pressure will continue in direct proportion to population size. In the wetland models it was assumed that changing availability of resources changes peoples' behaviour, such that increased effort required to harvest resources due to stock declines results in marginal users falling away and/or a decrease in user harvests. In a worst case scenario, the opportunity costs of peoples' time could be so low (due to worsening unemployment), that effort is stepped up to unexpected levels in order to secure harvests of resources. In this case, the economic extinction of resources would be at lower stock levels, thus carrying a much greater risk of ecological extinction. As resource stocks decline, their increasing scarcity is likely to lead to increasing prices, and thus the gross value of resources harvested may not necessarily decline. However, the concomitant increase in effort required to maintain these harvests would offset this effect to some extent, in that the input costs to harvesting would increase. The extent to which prices and costs increase has an important bearing on the net value of resource use. It is reasonable to assume, as assumed in the wetland model, that these changes offset one another, and that the net value of a harvested unit remains constant as stocks change.

Fish are the most important natural resource harvested in all four wetlands, and in all cases, local fishers described declines in the availability of this resource, on the basis of their own experience of decreasing catch per unit effort. The models predict that fisheries will continue to decline, in some cases precipitously, to a point where most fishers will have to resort to other means of making a living within the next twenty years. Although catches will continue to increase with increasing effort in at least three of the wetlands, overall catches are likely to level off and then start to decline within the next ten years. In the Lower Shire, the fishery appears to have already undergone a major collapse. With continued use of unselective fishing gear, particularly small-mesh nets, exacerbated by the proliferation of water weeds and decreasing water quality in wetlands such as the Lower Shire, the fisheries are unlikely to recover.

The ecological impact of overexploitation of animal resources is already very apparent in all of the wetland sites. In the Lower Shire, even waterbirds are scarce in comparison with the other sites. The harvest of other animal resources by rural households is expected to decline even further over the next twenty years. Even if current overall harvests could be maintained, this will be spread over an increasing number of households, which means that average household income from hunting are likely to decline dramatically. In reality, under this scenario it is likely that the wetlands will experience further population reductions and local extinctions within the next 20 years.

Plant resources appear to be in a much healthier state. According to our preliminary estimates, stocks of reeds, papyrus and grasses greatly exceed current overall demand, and will continue to do so for the next twenty years, even when taking wetland conversion by increasing subsistence agriculture into account. However, local inhabitants frequently reported a decline in the availability of these resources. Two factors account for this. Firstly, not all of these stocks are equally accessible, and while stocks might be abundant in the wetland, local stocks around villages tend to get depleted, thus necessitating increased travel to harvest resources. Secondly, with increasing burning for grazing and cultivation, stocks of plant resources are less available for harvest. This does not affect productivity of reeds and grasses in the long run, but it does affect the availability of locally accessible resources. Thus, under the existing scenario, household income from these resources will begin to decline within the next twenty years, mainly due to increased burning and, to some extent, also due to increasing competition for these resources. Similarly the supply of palm leaves does not appear to be under threat, as long as the trees themselves are abundant in the wetlands. However, where palm wood is harvested extensively, as in the Delta, palm trees may become locally depleted. Mangroves are a relatively productive resource, and are abundant in the Delta. There appears to be no immediate threat to the supply of mangroves from harvesting, but the ecosystems themselves are being damaged by overexploitation (DNFFB 1998), which suggests that current levels of use are not ecologically sustainable. A greater threat to the supply of mangrove wood is that of clear-felling land for cultivation.

The predicted effects of current trends continuing into the future are that overall harvests of plant resources will continue to increase for several years before levelling off, and in some cases, declining. Household income from these resources will decline slightly over the long run. The effect of a decrease in food plant availability may be particularly severe in some areas, especially where people depend on these plants to see them through the lean months.

Under this scenario, the current economic benefits of the wetlands are not sustainable. Although overall incomes may increase at first as populations and use levels increase, this will likely begin to decline in the future. Household incomes are likely to decline from the present situation with the next generation suffering the consequences.

The net present values of the Barotse wetlands under different management scenarios are summarised in Table 7.3.3.

7.3.2 Wise use scenario

In each of the wetlands, it would be possible to put in place actions which lead to improvements in the sustainable use of natural resources.

Without taking population control into account, this would require two main sets of actions:
1. the controlled use of resources such that harvests do not exceed production.
2. control of potentially destructive activities such as burning.

A constant harvest can be sustained at any level of production, but ideally, from an economic viewpoint, should be manipulated to achieve the stock level at which the optimal sustainable use is possible. Where input costs are low, as in artisinal or subsistence harvesting, this is close to the stock level which yields the maximum sustainable harvest. Thus, where stocks are below the level required to achieve optimal sustainable yield, harvesting would have to be reduced to the extent that allows the stock to recover to this point.

In the wetland models, the following controls were assumed:
1. Regulation of fishing gear so that 50% of the stock is unavailable for exploitation and is potentially able to grow to the next age class.
2. Regulation of spatial harvesting of reeds and papyrus, so that 50% of the harvestable mature stems remain in any patch, as habitat for wetland biota.
3. Drastic reduction in the level of burning. Burning levels are linked to cattle herd size.

In all cases these measures lead to recovery of stocks, although fish stocks do not recover to pristine levels. Household harvests of fish and plant resources are maintained, albeit at slightly lower levels than at present. The resultant net present values of the Barotse wetland under this type of management are summarised in Table 7.3.3. These values are somewhat higher than the values under the "do nothing" scenario, and are more evenly spread over time (ie. future users are better off).

7.3.3 Protected area and wise use scenarios

In order to maintain representative functional ecosystems in which biodiversity protection is maximal, it is necessary to set aside areas of strict protection. Any level of harvesting will affect ecosystem dynamics, but the overall ecological effects of harvesting some resources are likely to be greater than others. In other words, total hands-off protection is not always necessary in order to maintain a high level of diversity, but would be necessary if the goal was to maintain a representative ecosystem in its fully natural state. The latter goal is often a prerequisite for encouraging certain types of ecotourism. For the sake of scenario analysis, we examine the case of hands-off protection as the surest way of conserving wetland biodiversity. All of the study areas are large, however, and it is assumed that viable populations of wetland biota could be conserved within a portion of each wetland, rather than excluding all human use from the wetland. We examine three levels of protection: 10%, 25% and 50%.

In the case of animal resources, particularly fish, the protected area is likely to act as a source area for stocks in the remainder of the wetland. Protected plant resources do not, however, enhance stocks in the remaining wetland area, but serve as important habitat for wetland biota. The extent to which a protected area enhances fishing income is dependent on the spatial elements of protection and on the biology of the fishes, with certain species tending to disperse from protected areas more than others. In general, in an area which is overfished, a protected area will likely result in increased catches and catch per unit effort in the adjacent areas.

Protected area status will also potentially enhance the level of tourism in the wetlands, but probably only on any significant scale if it is coupled with the reintroduction of mammalian wildlife. Where some infrastructure is already in place, such as in Caprivi, the potential is reasonably high. In the Lower Shire, the existence of National Parks close to the wetland, and its proximity to Blantyre, enhances tourism potential to some extent. However, tourism infrastructure is currently of poor quality in the vicinity of the Lower Shire wetland, and would require substantial capital input. The Barotse wetland and the Delta are comparatively remote, with little in the way of good road or air travel infrastructure. These problems can be overcome to a limited extent by the establishment of exclusive tourism ventures which involve fly-in safaris, as is presently the case in a few localities around the Delta.

The potential economic and community benefits from tourism differ depending on the type of enterprises developed. For example, a private investor could obtain a concession to operate a tourist facility, providing employment opportunities, but no direct revenue to the local community. Alternatively, a private investor could collaborate with a community in a profit-sharing joint venture, or a community could develop its own enterprise. The latter are usually more low-key tourism enterprises, such as campsites, and are only likely to succeed where there is already some threshold level of tourism due to existing facilities. Joint ventures may be as simple as incorporating a bed night levy which goes to the local community. An ecotourism lodge is usually an efficient use of land in terms of national economic returns (Ashley & Garland 1994). Based on financial-economic models of tourism facilities in the Caprivi and Cunene regions of Namibia, Ashley & Garland (1994) calculated the potential economic returns from different types of tourism ventures associated with conservation areas (Table 7.3.2). We use these data as the basis for estimating potential tourism value of the protected area of wetlands.

Table 7.3.2. Potential income from different types of tourism development, in US$ (1999), adapted from Ashley & Garland (1994).

	Up-market tourism lodge (private entrepreneur)	Joint venture up-market lodge	Community enterprise
Visitors per year	300 - 700	300 - 700	200
Capital investment	120 000 - 264 000	120 000 - 264 000	480 - 2400
Number of local jobs	6 - 15	6 - 15 +	1 - 30
ERR on investment	26 - 39%	27 - 41%	42%
Net income per year (1994)	48 000 - 79 000	48 000 - 84 000	960 (23 500)*
Net income per ha (1994)	2.4 - 6	2.4 - 6	0.01 (0.5)*

* with economic value on social benefits

The resultant values of the wetland under these scenarios are summarised in Table 7.3.3 With 10% protection, combined with wise use of the rest of the wetland, the Barotse wetland is worth more than in the status quo scenario, and slightly less than in the wise use scenario without protection. Value to the local communities declines considerably at greater levels of protection, and economic value of the wetlands also declines, though to a lesser extent. However, the latter does not take into account existence value and the intrinsic benefits of biodiversity protection.

Table 7.3.3. Estimated net present values (NPV) in US$ (millions) of the Barotse wetland under diffferent management scenarios (time scale 20 years, discount rate 8%). Financial values are value to the wetland communities, and economic value is value to the nation.

	Do nothing		Wise use		Wise use + 10% protection		Wise use + 25% protection		Wise use + 50% protection	
	Fin	Econ	Fin	Econ	Fin	Econ	Fin	Econ	Fin	Econ
Agriculture	46.3	29.0	46.3	29.0	44.5	26.9	41.6	23.5	35.8	16.7
Natural resources	37.9	33.2	40.4	35.4	40.1	35.1	38.8	34.0	33.6	29.4
Tourism	0	0	0	0	0.9	2.5	2.3	6.2	4.6	12.3
TOTAL	84.2	62.2	86.7	64.4	85.5	64.5	82.7	63.7	74.0	58.4

7.3.4 Agricultural development scenarios

Wetlands are vulnerable to agricultural development, and many wetlands worldwide have been largely transformed by such activities. There has been almost no transformation of the Barotse and Caprivi systems, but significant areas of the Lower Shire and Delta are under commercial sugar schemes. Rice schemes are a possible future development option in the Barotse wetland, and a sugar scheme has been mooted for the Caprivi. The economic viability of such schemes will differ from wetland to wetland, and will be heavily influenced by access to markets. These factors make largescale developments in Barotse and Caprivi an unlikely scenario, and as concluded in chapter 4, they are unlikely to be economically viable. The Delta has potentially better access to markets by river and ocean transport to Beira, although water transport is currently poorly developed. The Shire, however, has relatively good access to markets, mainly via road transport to Blantyre.

Table 7.3.4 Estimated net present values (NPV, over 20y, discount rate 8%) in US$ (millions) of the Barotse wetland under different management scenarios, all incorporating wise use, which include different levels commercial agricultural development, shown in ha Values exclude the value of the commercial development, but give the opportunity cost of the development (time scale 20 years, discount rate 8%). Opportunity costs are costs relative to the equivalent protection and wise use scenario.

	0% protection + 5000 ha development		25% protection + 5000 ha development		25% protection + 10 000 ha development		25% protection + 20 000 ha development	
	Fin	Econ	Fin	Econ	Fin	Econ	Fin	Econ
Agriculture	46.3	29.0	41.5	23.4	41.5	23.3	41.4	23.2
Natural resources	39.1	34.2	37.6	32.9	37.1	32.4	36.0	31.5
Tourism	0	0	2.3	6.2	2.3	6.2	2.3	6.2
TOTAL	85.4	63.2	81.4	62.5	80.9	61.9	79.7	60.9
Opportunity cost	1.3	1.2	1.3	1.2	1.8	1.8	3.0	2.8

The financial benefits of such schemes to local wetland communities are mainly felt through increased employment opportunities, albeit for the most part in the form of unskilled, minimum wage labour. However, commercial agricultural schemes also frequently bring considerable infrastructural development to the wetlands, improving roads, drainage systems and communications links. Such advantages are currently highly apparent in the Delta, with the restoration of the Sena Sugar estate. Also, it is the existence of the ILLOVO sugar estate in the Lower Shire area that supports the relatively good access road between Blantyre and the estate. This study does not attempt to quantify the potential financial or economic benefits of commercial schemes in these wetlands. However, we investigate, in rough terms, the effects such schemes could have on values obtained through existing use of the wetlands. There is no evidence from this study to suggest that such employment will reduce the demand for natural resources, and we do not make this assumption in the model. The loss of value through reduced access to wetland resources can be regarded as the opportunity cost of potential schemes, and thus we illustrate the net present value (at 8%) of the total financial benefits to the wetland community and the national economic benefits that would have to be achieved in order for such developments to be an advantage. Note that this does not take social costs into account.

7.4 EXTERNAL MANAGEMENT ISSUES

7.4.1 Water quantity and quality

Development outside of the wetlands themselves can potentially have profound effects on the wetlands, and need to be considered as a broadscale, regional, or national-level management option which impacts on the economic values generated by wetlands. Governments and regional development authorities have the option to develop major water supply or hydro-electric power schemes which affect the hydrology of wetlands, having, in turn, a number of ecological effects. Hydrological developments along the Zambezi are among the largest in the world, and a number of new development possibilities have been identified for the future. In practice, hydrological schemes, such as Kariba and Cahora Bassa, already affect the Lower Shire and Delta wetlands. Both extractive, e,.g. irrigation, and non-extractive, hydro-electric power, schemes have a marked effect on the hydrology and water quality of aquatic systems downstream. The effect of the Cahora Bassa dam on the Delta has been profound, and is summarised as follows (Davies & Day 1998):

- No flooding since 1978
- Appearance of vegetated islands in the main channel
- Major vegetational changes, with extensive bush encroachment
- Increased reeds
- Some 40 - 60% of mangroves have dried out and died back
- Erosion of the coastal zone
- Drying out and depletion of floodplain grasslands
- Diminished waterfowl populations
- Decline in floodplain recession agriculture
- Decline in floodplain and coastal fisheries

With proper design and water release regimes, the effects of hydrological developments need not be as severe as has been the case in the Delta. However, alteration of hydrology cannot occur without some impact on downstream ecosystems, and the inclusion of further hydrological extraction in any management scenario will decrease the value of the wetland. The likelihood of hydrological alteration upstream of the Barotse and Caprivi wetlands is relatively small, however, but the Lower Shire wetlands are at some further risk. In any of these cases, the economic benefits of hydrological developments which affect the wetlands are usually likely to be substantial in comparison to the scale of benefits derived from the wetlands themselves, but the beneficiaries are generally separate communities from those bearing the environmental costs, which raises some serious distributional issues. The situation in the Delta can probably only be improved, and any scenario which involved the restoration of flood regimes and flow, if only in part, would likely yield major benefits over the medium to long term.

In addition, economic development within the wetland catchment areas leads to pollution of the wetlands, unless properly controlled. Agricultural and urban development within the catchments of the wetlands yield potentially large economic benefits to the countries involved. However, the pollutants emitted from these developments into wetlands and their catchments threaten the ecological integrity of the wetlands once levels exceed the wetlands' absorptive capacities. This in turn leads to eutrophication and reduction in some biological resource stocks. A scenario where pollution levels are allowed to increase would reduce values in all the wetlands after this point, and is likely to have measurable effects in the short term in the Lower Shire.

Of major concern is the invasion of water weeds in the wetland systems. Without control and management, these weeds further threaten wetland resource stocks, as well as impacting on access to wetland resources. The problem is particularly severe in the Lower Shire. Thus any scenario which includes a laissez-faire approach to water weeds will have a lower net present value, particularly in the Lower Shire.

7.4.2 Population

In all scenarios, it was assumed that current population trends continue as at present. It is quite possible, however, that rates of urbanisation change over the next twenty years, and that the AIDS epidemic, which is particularly severe in the Zambezi basin countries, has significant effects on mortality and population growth. While a decrease in population growth would, under normal circumstances, significantly improve the wellbeing of individuals through decreased competition for scarce resources, it is important to note that AIDS will not only affect numbers of people, but will selectively remove the more economically active members from the population, hence having a potentially devastating impact on rural household wealth.

7.5 SUMMARY AND IDENTIFICATION OF THE MOST DESIRABLE WETLAND MANAGEMENT SCENARIO

The general conclusions from the above are summarised in Table 7.5.1, with some considerations of their distributional implications. It would appear that optimal management of the wetlands involves applying a combination of management options in order to maximise benefits to the wetland communities and society as a whole. In general, the wise use scenario increases the value of the wetlands to wetland inhabitants over that of the status quo scenario. The protection of part of the wetland imposes little in the way of opportunity costs to wetland inhabitants, and may enhance wetland productivity more than suggested using the conservative assumptions in the model. As well as securing national biodiversity resources, protected areas potentially bring benefits to the economy and local inhabitants, and these are likely to increase disproportionately with increased size of the protected area. The opportunity costs imposed by commercial agricultural developments are not particularly high, and where these are economically viable, their development is likely to bring considerable benefits to wetland communities. The main danger of such development, however, is the attraction of people from outside into these areas, increasing pressure on resources.

Table 7.5.1. Economic costs and benefits of different management actions.

	Economic benefits	**Economic costs**
Do nothing	Initially relatively high direct use values. Benefits at a local level.	Gradual decline in most indirect use, option and existence values, eventual decline in direct use values. Costs at a local, national and regional level.
Wise use and management	Maintenance or gradual improvement of non-consumptive direct use, indirect use, option and existence values. Benefits mainly at the local level.	Possible immediate decline in some consumptive direct use values. Additional wetlands direct management costs. Costs mainly at the local level.
Strict protection	Augmentations of stocks beyond protected area with potential improvement of direct use values. Maintenance (or gradual improvement) of non-consumptive use, indirect use, option and existence values at a local, national and regional level.	Immediate loss of all consumptive direct use values for the area protected. Additional wetlands direct management costs. Costs at local and national level.
Agricultural conversion	Agricultural income and employment, with benefits at the local and possibly at the national level.	Immediate loss of most direct use values, option and existence values, decline in some indirect use. Costs mainly at a local level.
Alteration of hydrology and water quality	Economic development at a national level, recreational and fisheries benefits upstream of wetlands.	Gradual decline in most direct use, indirect use, option and existence values. Costs at a local level, and possibly at national and international levels, depending on severity of impact.

7.6 FACTORS LEADING TO WETLANDS DEGRADATION OR SUSTAINABLE USE

All four wetland areas in this study have been degraded to some extent, and unless checked, this trend will continue. There are many proximate causes of this degradation, which are driven by economic forces. Individuals behave rationally by basing decisions on an assessment of costs and benefits. These are in turn affected by a wide range of policies and prices. Because national, communal and private interests often differ, it is important for communities and or government to provide incentives leading to the more sustainable, efficient and equitable use of natural resources.

7.6.1 Over-exploitation of resources

There are four main proximate reasons that natural resources are overexploited in these wetlands.

7.6.1.1 Ecological and biological knowledge

The optimal sustainable management of biological resources cannot be achieved without understanding the status, carrying capacity, growth, behaviour, immigration and emigration and interdependence of their component stocks. This is particularly important for multi-species fisheries, where responses to fishing pressure and indeed, to different types of conservation measures, are complex. The importance of ecological understanding of these systems cannot be overstated, yet there is very little understanding of the stocks of resources in all four of the wetlands in this study. Part of the solution lies in tapping traditional knowledge systems as far as possible, but these clearly need to be supplemented with scientific research.

7.6.1.2 The growth rate of resources

Slow growing resources are particularly vulnerable to overexploitation. These include some of the larger fish species which take several years to mature, and certain plant resources such as palms. Where annual production rates are lower than peoples' private discount rates (or at least the rate at which their money would gain interest in an alternative investment), there is a tendency to overharvest, or "mine" natural resources. The explanation for this behaviour is that it makes more economic sense to convert stocks into cash which would be more productive than the resource itself. Slow-growing resources thus require particularly rigorous control if they are to survive as components of the ecosystem, and their conservation can only be justified in economic terms if these benefits (e.g. ecotourism, spiritual value, existence value) outweigh the opportunity costs of their preservation.

7.6.1.3 Ownership of resources

Where ownership is ill-defined or weak, for example through the breakdown of communal or government control, there is no limitation on access to resources, leading to an "open-access" situation. In such a case, regardless of the awareness of the dangers and consequences of overexploitation, including knowledge of the fact that future users may suffer, people will tend to over-utilise resources. This is simply because if they do not, someone else will, as illustrated in Hardin's (1968) "Tragedy of the Commons". This problem, that "freedom in the commons brings ruins to all" is also termed "commonised, costs, privatised profits" (Hardin 1993), i.e. costs are shared by many while profits are realised by a few, and occurs virtually wherever access to a publicly- or communally-owned resource is unregulated.

The only solution to the open access problem is to establish well-defined property rights, whereby government or traditional authorities have strict control over communal resources and are able to control the allocation of resource use rights. Under traditional authority, property rights might be devolved through the various levels of community leadership. Alternatively, where state control exists, property rights can be devolved through the use of concessions, licences, permits and franchises. The choice of traditional or governmental property rights instruments is fundamental to determining their success. Traditional authorities have historically controlled the access to resources in all four study areas, but these institutions have broken down to various extents, and the problem has been exacerbated by the attempt to impose government authority within the same systems. In general, local institutions will be far more effective than provincial or national ones in supporting biodiversity conservation.

Well-defined property rights are a prerequisite for sustainable use and management of natural resources. However, securing tenure is a necessary, but insufficient condition for biodiversity conservation. It has to be coupled with strong leadership and adequate knowledge and understanding of the resources over which they have stewardship. This is sometimes better achieved through joint collaborative and co-management institutional arrangements.

7.6.1.4 Poverty

Even where property rights are well defined, poverty can be an overriding force in driving the unsustainable use of resources. When people are struggling to survive today, there is no possibility of saving for tomorrow. Poor people have disproportionately high private discount rates, which means that even fast growing resources will tend to be mined. Furthermore, because the opportunity costs of their time are relatively low, they will tend to increase harvesting effort beyond the limits that would define economic extinction of resources among richer communities. Poorer communities will thus also take more risks and will be more prepared to flout government or traditional control over access to resources.

7.6.1.5 Population: the ultimate problem

The population problem underlies many of the above problems. For example, open access to resources is not a problem until increasing resource demands exceed their sustainable supply. Increasing population in an area of limited resources and employment opportunities means that income is spread ever more thinly, leading to increased poverty. Poverty, in turn, forces people to turn increasingly to "free" environmental resources for survival.

7.6.2 Value systems

The perceived low costs of livestock grazing and the relatively low benefits of investing in biodiversity lead to a distorted situation in which investment in livestock seems disproportionately high. The traditional benefits of cattle, which greatly exceed their financial benefits, are regarded as far more important than the effects of overgrazing or excessive burning for grazing, both of which impact on wetland biodiversity and resource stocks. In addition, there is often a relatively low regard for the protection of biodiversity *per se* among rural, poor or less educated communities, especially where the benefits from wildlife are restricted by lack of tenure and low market values and where some existing benefits, like tourism values and existence values, accrue beyond the local communities.

7.6.3 Lack of biodiversity protection

There has little effort at the protection of biodiversity in the four study areas, except in the Delta, which contains the extensive Marromeu Buffalo Reserve and private conservation concessions on its periphery, and the Liuwa Plain National Park bordering on the Barotse floodplain. Governments have little incentive to protect these wetlands because generally the costs of doing so outweigh tangible benefits. Even where protected areas are established, there is often little incentive for maximising their economic benefits when revenues go to central government coffers. Similarly, where protection does not include community participation, there is little incentive for local communities to comply with protected area regulations. In general, with a shortage of public funds for conservation, protection can only be achieved through encouraging community conservation initiatives or partnerships with the private sector, and financial incentives can be put in place to encourage such investment. In the Caprivi area, efforts are being made to allow local communities to establish conservancies which will generate income from tourism, but the degree to which tourism increases may be affected by political disturbances.

7.6.4 Ecosystem degradation

The wetland ecosystems have also being degraded through altered hydrology and water quality. The reason for this is that the damaging processes are treated as externalities in the economic decision process. For example, damage costs incurred by polluting industry or agriculture are not taken into account in cost-benefit analysis. Similarly, the instream flow requirements of aquatic ecosystems have long been ignored in the hydrological development projects. Even though the dire ecological and economic consequences of the Cahora Bassa dam were predicted in the 1970s, no action was taken to mitigate these effects (Davies & Day 1998). The only way to solve these problems is for such costs to be internalised so that they affect investment decisions.

8 MAXIMISING WETLAND BENEFITS: A POLICY ANALYSIS

8.1 INTRODUCTION AND OVERVIEW

Policies are set by governments in order to influence the ways that national economies work, overall and at the level of individual sectors. They aim to reach certain goals, targets and patterns of economic activity by using various economic, market, legal and institutional instruments to encourage or discourage particular forms and types of economic activities. For example, macroeconomic policy throughout the Zambezi Basin states manipulates exchange rates, money supply and interest rates so as to achieve a particular rate of economic growth or to generate foreign exchange, agricultural policies use a combination of subsidies, taxes and credit arrangements in order to promote the goals of food security, increased export earnings and rural income generation.

Policies, and their various supportive instruments, influence wetlands in the Zambezi Basin because they shape the economic activities that impact on their ecological, biological and hydrological status. While activities such as the establishment of protected areas, the exploitation of wetland resources, the implementation of upstream water-based developments or the use of wetland areas for irrigated agriculture, have a *direct* influence on wetland status, it is the policies which encourage these activities to take place in the first place that form the *underlying* or *root* economic causes of wetland status. Because policies in Malawi, Mozambique, Namibia and Zambia often ignore wetland impacts, or do not operate well in practice, they can send signals that encourage producers and consumers to degrade wetlands in the course of their economic activity, or fail to set in place the conditions under which wetlands are conserved. Conversely, the policies and their supportive instruments in these countries can provide valuable tools for wetland conservation. Analysis of these policy factors is a key stage in the economic analysis of wetlands.

This chapter looks at the links between economic policies and wetland status. It analyses the policies for major sectors of the economies of Zambezi Basin States, and describes how these policies have impacted on wetland status to date. The chapter isolates the main economic policy causes of wetland degradation and loss as well as pointing to policy elements that have the potential to encourage wetland conservation. It identifies the most likely future scenario for each of the different study sites in the Zambezi Basin, under current economic policy trends, and makes recommendations relating to economic policy conditions and instruments that can be used to encourage the most desirable future wetland scenario in economic and ecological terms – that which includes a strong element of wise use and sustainable management.

8.2 INSTITUTIONAL AND POLICY FRAMEWORKS THAT AFFECT WETLANDS

Wetland ecosystems cross-cut different sectors of the economy, and a number of policy factors therefore affect sustainable wetlands utilisation and management. Macroeconomic policy, by defining the overall parameters within which countries operate, sets the terms and conditions under which economic activities which impact on wetlands are carried out. In turn sectoral policies relate to specific activities which utilise wetlands goods and services, affect the integrity and status of wetlands or define mechanisms for wetlands management.

8.2.1 Macroeconomic Policy

The Zambezi Basin countries have in the past followed very different macroeconomic and development models after their independence from colonial powers. Moçambique, and to a lesser extent, Namibia, have only recently started the task of economic reconstruction after a protracted period of civil unrest, Malawi was primarily under a capitalist regime and Zambia a centrally-planned socialist economy. However, recent and on-going changes in their national economies are similar. A combination of economic stagnation, rising unemployment, declining economic growth and severe public sector deficits and balance of payments problems, compounded by national and regional unrest and widespread drought and encouraged by external donor pressure, have, over the last decade, resulted in the adoption of economic stabilisation and structural adjustment measures. Changes in macroeconomic policy primarily comprise a move from heavy regulation and government control in most sectors of the economy to a model of market-driven and private-sector led growth.

Policy impacts on wetlands primarily depend on on-the-ground action in individual sectors of the economy. Macroeconomic strategy is of relevance only insofar as it promotes or discourages particular sectors of the economy which impact on wetlands, and sets in place certain conditions or trends which present niches for wetlands conservation or degradation. Of particular concern in the macroeconomic policies of study countries is the promotion of sectors whose expansion presents major threats to wetlands integrity and status as sources of conversion degradation and pollution – agriculture, fisheries and industry. Conversely, increasing privatisation and the devolution of the role of the state, as well as the recent incorporation of sustainable development concerns into macroeconomic strategy, presents positive niches for wise wetlands utilisation and management. The extent to which sectoral policies reinforce these trends and impact on wetlands is examined below.

8.2.2 Sectoral policies

Of particular relevance to wetlands are policies in the natural resources sector – including environment, land, water, fisheries, forestry and wildlife – because they define the way in which wild resources are controlled, utilised and managed, and policies in productive sectors of the economy – including agriculture, urban settlement and industry – because they deal with activities which have the potential to impinge on wetlands integrity and status through conversion, degradation and pollution.

In none of the countries under consideration in this study is there currently a single institution or policy which is concerned specifically with wetlands. Only in Zambia is a national wetlands policy in the early stages of preparation. This lack of integrated wetlands institutional capacity or policy, in combination with the fact that wetlands goods and services are linked to many other sectors of the economy, means that multiple institutional and policy factors impact on wetlands. As illustrated in Table 8.2.1, wetlands currently rely on a large body of policy and legislation, and institutional responsibilities for different aspects of wetlands utilisation and management are spread between different government agencies.

Table 8.2.1. Institutional and policy coverage of wetlands issues

Wetlands issues	Sectoral policies, legislation and institutions									
	Environ-ment	Water	Fisher-ies	Wildlife	Forests	Agricul-ture	Industry	Tourism	Land	Local author-ity
Water supply and abstraction	Ŏ	Ŏ				Ŏ	Ŏ			Ŏ
Water conservation	Ŏ			Ŏ	Ŏ	Ŏ			Ŏ	Ŏ
Water pollution	Ŏ	Ŏ					Ŏ			Ŏ
Protected areas	Ŏ			Ŏ	Ŏ			Ŏ	Ŏ	
Biological resources and diversity	Ŏ			Ŏ	Ŏ			Ŏ		
Land/ resource use and tenure			Ŏ	Ŏ	Ŏ	Ŏ		Ŏ	Ŏ	Ŏ

All these sectoral policies affect wetlands because they touch on important issues to wetlands utilisation and management, including the integrity of wetlands catchments and sources, the conservation and utilisation of wetland lands and resources, the role of the state and civil society in wetlands tenure and management and the on and off-site conversion, degradation and depletion of wetlands. Major sectoral policies and institutions which impact on wetlands utilisation and management are:

- **Agriculture**, which concerns a major land use in, and potential source of conversion of, wetlands areas – crop and livestock production – and defines the ways in which it is carried out;
- **Environment**, which sets the overall framework for wetlands utilisation and management, as well as their protection against conversion, degradation and pollution;
- **Fisheries**, which deals with a major wetland resource and defines the levels, types, methods and tenurial arrangements under which it is carried out;
- **Forests**, which as well as dealing with the integrity of wetlands sources and watersheds, relates to the ownership, utilisation and management of forested parts of wetlands areas;
- **Industry**, which relates to the ways in which activities which rely on a major wetland ecosystem function – water – and potentially contribute to wetlands pollution, are carried out, and set standards for their implementation;
- **Land**, which defines the way in which land, including wetlands areas, can be owned, held, used and transferred;
- **Local authority**, which provides the major set of instruments which define authority and decision-making at the local-level, including land and resource ownership, use and conservation;
- **Water**, which sets conditions for the ownership, abstraction, use and protection of a key wetland ecosystem good and service;

- **Wildlife**, which as well as setting in place national standards for wild flora and fauna conservation and utilisation, defines the way in which protected wildlife areas and resources – including wetlands – can be owned, utilised and managed.

- **Tourism**, which influences the degree and type of recreational use of wetlands by non-locals, and provides conservation incentives to locals.

Although their concerns are overlapping, in general terms and specifically as they relate to wetlands, different sectors are governed by separate institutions, laws and policy. Their workings are largely uncoordinated and their policy and legal frameworks fragmented and based on aims other than sustainable wetlands utilisation and management. Sectoral policies contribute to national development strategies and macroeconomic goals.

Sectoral policies may either have direct relevance to wetlands utilisation and management, or they may contain provisions which affect wetlands indirectly. The former include policies dealing with environment and natural resources, e.g. environment, water, forestry, wildlife, and fisheries policies. The latter policies, concerned with sectors which impact on land use and water quality in wetlands areas, include land, agricultural and industrial policies. Coverage of wetlands issues is poor in all these sectoral policies, which as a result have mixed and sometimes contradictory implications for sustainable wetlands use and management.

In all of the study countries there is a two-tier system of environment and natural resource conservation policy comprising umbrella policy which co-ordinates and sets standards for national environmental management, under which separate but subordinate sectoral policies for wildlife and forestry deal with on-the-ground wild species and protected areas conservation. All of these environment and natural resource conservation policies are relevant to wetlands utilisation and management because they provide for wetland protection and set the conditions under which wetland land and resources may be held, managed and used. Although generally consistent and supportive of wetlands, having the primary goals of conservation, sustainable utilisation and benefit sharing, policies in the environment and natural resource sectors contain little explicit reference to wetlands, are fragmented and often unclear.

Policies which govern water and fisheries management and regulate the ways in which they are used and exploited have a direct impact on wetlands integrity and status. In the study countries, the main focus of water policy is on maximising the coverage and level of water developments, setting administrative and financial structures for water control and usage and on ensuring standards for water quality. Fisheries policy, mainly focusing on commercial fisheries, aims to increase catches for domestic and export markets and provides for the licensing and regulation of fisheries methods and activities. Despite their reliance on wetlands ecosystem functions, in neither sector does policy explicitly recognise – or attempt to safeguard the source of – this dependence. Both are concerned with maximising abstraction and use rather than protecting their sources through conserving wetlands ecosystems and resource stocks.

Policies dealing with land uses have major impacts on wetlands because they define the terms and conditions under which wetlands and their surrounding areas are owned, managed and used. In all study countries there is a trend towards increasing land privatisation, with the primary aim of expanding and diversifying arable land and livestock production for food security, employment and export purposes and promoting industrial developments. Although agricultural policies, in combination with policies dealing with land tenure and local authority, contain provisions relating to natural resources, these are mainly geared towards ensuring that land is used to its maximum agricultural potential and sometimes they also act to minimise the degree to which landholders have control over the natural resources lying on their land. Industrial and urban policy contains little consideration of either the sustainability of developments or their environmental impacts. Neither land, agricultural, urban or industrial policy contain specific consideration of wetlands in the study countries. Recently developed land use policies and guidelines, by incorporating environmental concerns, to some extent overcome the omission of wetlands issues in these sectoral policies, and in the study countries contain explicit reference – although they vary greatly in the level of detail they accord – to threats to wetlands integrity and status. In general the main focus of land, agricultural and industrial policies is, however, on economic growth rather than sustainable development and environmental conservation.

In addition to the abovementioned policies, the social policies, such as primarily health, education and welfare are likely to have some influence on wetlands utilisation and value. Most countries place great emphasis on the improvement of these sectors. Population policy is obviously also of critical underlying relevance to all natural resource issues, not least wetlands management, but it is seldom presented in this light. It is generally acknowledged that positive social development has positive effects on natural resources due to decreased dependency, decreased demand due to decreased population growth and increased sense of stewardship, but the actual links are not well understood. These social policies are not examined any further in this study. The major sectoral policies apart from social policies are described in more detail below.

8.2.2.1 Environment

Over the last decade a single co-ordinated environmental management policy has been developed in each of the study countries. Prior to this, responsibilities for national environmental management were fragmented and spread between different sectoral agencies, and there was no definitive or cross-sectoral statement of environmental management, environmental standards or environmental protection in Malawi, Moçambique, Namibia or Zambia. In all countries environmental policy and legislation mainly touches on wetlands through presenting an overarching framework for sectoral planning and development which incorporates environmental concerns, setting standards and penalties for environmental degradation and pollution and establishing a national agency responsible for environmental management and co-ordination.

8.2.2.2 Water

Water policy is of central relevance to wetlands because it deals with the quality and use of a major wetland ecosystem service and component of wetland areas. Of primary importance is the extent to which water policy, and its supporting legislation, are concerned with maintaining the ecosystem functions associated with wetlands both in terms of water abstraction and use as well as through maintaining water quality standards and water-based waste disposal regulations. Although there is an elaborate body of policy and legislation dealing with the water sector in the study countries, ecological issues are underplayed, and in no country is there specific mention of wetlands ecosystems in water policy or legislation. A major concern of water policy and national water master plans in the study countries is to regulate water quality and abstraction through the establishment of institutions responsible for water management, introduction of standards for water quality and imposition of guidelines for water-based developments.

Similarly other aspects of water policy and legislation in study countries focus mainly on the ways in which water is stored, distributed and used for domestic, agricultural and industrial purposes, not the conservation of water sources and watersheds. Although additional international agreements, discussed below, to some extent supplement and broaden these provisions, national water policies almost completely fail to recognise or safeguard the role of wetlands in maintaining and regulating water supply or ensure that minimum ecological water flow requirements are met.

8.2.2.3 Wildlife and forests

Although only in Moçambique are they combined – Malawi, Namibia and Zambia all have separate documents dealing with wildlife and forestry – the major aims of new wildlife and emerging forestry policy are similar in study countries. All represent a move from formerly protection-based management regimes to ones which depend on the sustainable utilisation of natural resources and on devolving the role of the state in wildlife and forest management. By defining the conditions under which protected areas are established and run, wild ecosystems and their component plant and animal resources used and setting in place the administrative arrangements and mechanisms under which private and communal landholders are permitted to manage and use wild resources, wildlife and forestry policy have great relevance to wetlands.

Of particular concern to wetlands use and management is the recent devolution and liberalisation of forestry and wildlife sectors. Although – to varying degrees – new policy retains the overall ownership and control of the national forest and wildlife estate in the hands of the state, it includes major steps away from until recently highly controlled and protected wildlife and forestry sectors. Recent legal, policy and institutional reforms have led to a much greater recognition of the role of forests and wildlife outside formally protected areas and aim to substantially increase the degree to which they may be utilised managed, and their benefits shared, by the private sector and local landholders.

8.2.2.4 Fisheries

Fisheries policy relates to wetlands insofar as it defines the extent and ways in which the utilisation and management of a major wetland resource is carried out. By controlling the areas, species and methods used in fisheries production it has the potential to impact on wetlands in a number of ways. Existing fisheries policies and legislation in study countries however contain little consideration of either wetland ecosystem functions or of biodiversity and species conservation.

8.2.2.5 Land use and tenure

Policy on land use and tenure has important implications for wetlands management and utilisation because it defines the terms and conditions under which land – including wetlands – is owned, held and used. Whereas policy on land tenure relates almost exclusively to unprotected private, communal and state lands, land use guidelines contain consideration of lands both within and outside protected areas.

In all the study countries there is a large and complex body of policy and legislation dealing with the acquisition, ownership and transfer of land. Despite some mention of wetlands in land use guidelines in study countries it is clear that policy and legislation dealing with the acquisition, ownership and transfer of land contains little consideration of wetlands. In some cases the unclear or insecure nature of land tenure and control over land-based resources may act against sustainable wetlands utilisation and management.

8.2.2.6 Agriculture

The dominant land use in many wetland areas is agriculture. Agricultural activities also pose a serious threat to wetlands integrity and status through land conversion, abstraction of water and agro-chemical pollution. Agriculture is generally seen as a leading sector of the economy, with the potential to improve household and national food self-sufficiency, better arable and livestock production and increase high-value export crops. The expansion of area under production, intensification of existing enterprises, increased irrigated production and agricultural diversification are seen as major strategies to achieve these goals.

8.2.2.7 Urban settlement and industry

Urban and industrial policy have relevance to wetlands because these sectors have the potential to encourage the development and conversion of wetland areas as well as to lead to the discharge of wastes and effluents into wetlands. The main thrust of urban and industrial policy in study countries is to expand areas of settlement and industry as a means of economic development, while simultaneously ensuring access to basic infrastructure and services for the majority of the population.

8.2.2.8 Tourism

Each of the countries included in this study has a relatively recent tourism policy. Tourism policies and trends are described in detail for the Zambezi Basin countries in Van Riet & Low (1998). Community needs and the protection of natural resources are key elements in all of these policies, with a general promotion of a favourable environment for private sector involvement in the tourism industry, community participation and sustainable tourism development.

8.3 THE CURRENT POLICY ENVIRONMENT IN ZAMBEZI BASIN COUNTRIES

Throughout the countries under study, policies have been undergoing change over the last decade, in line with broader social, economic and political changes. Both government and economies have been liberalised, involving the dismantling of controls on markets and production and the increasing devolution of economic activity and decision-making to civil society and the private sector. National economic growth and development goals have been reformulated and sectoral policies updated to reflect these new, market-driven strategies. Simultaneously most natural resource sector policies have been rewritten, moving away from previously protection-focused regimes to ones which devolve the role of the state in environmental conservation, promote sustainable utilisation and encourage private sector and community-based management. These moves have the potential to significantly impact on the way in which wetlands are managed and utilised.

This section reviews the policy instruments, goals and strategies for the major sectors of the economy that influence wetland status in each of Malawi, Mozambique, Namibia and Zambia. The main aspects of policy in each of these countries are summarised in Appendix 3.

8.3.1 Zambia

Since Zambia embarked on its structural adjustment program in late 1991, the economy has been liberalised substantially, and the macroeconomic situation has improved considerably. Over the period 1999-2001, government economic policies focus on further reducing inflation, promoting economic growth, and moving toward a sustainable balance of payments position. The ultimate goal of these policies is to reduce the incidence of poverty in Zambia and to improve the well-being of the Zambian people. Strategies to achieve these goals include continued public sector cut-backs, privatisation, fiscal reforms, anti-inflationary measures, and the continued liberalisation of trade and exchange rates.

Although secondary to mining in terms of its contribution to national income, agriculture forms the main basis of rural livelihoods in Zambia, comprising an estimated 19% of GDP. Agricultural policy has as its main goals to promote more efficient smallholder production, with a view to increasing agricultural outputs and exports. The 1998 Agricultural Sector Investment Program (ASIP) is the main vehicle for the co-ordination of agricultural policies. Key aspects of the ASIP include liberalisation and decentralisation, in input supply and crop marketing, through price reforms and through the removal of restrictions on domestic and international trade. Fisheries policy continues to emphasise the development of commercial fisheries through the expansion of fishing area, increase of catches and development of aquaculture for the purposes of national food security, rural income, employment and export earnings. There is however no mention of the artisanal sector in fisheries policy – its emphasis is on commercial activities.

All land in Zambia has been owned by the State since 1975. Recent reforms in the land sector, formalised in the Land Act of 1995, have however made substantial changes to the conditions under which land can be held and allocated. Land can now be held under leasehold conditions on State Lands, Trust Lands and former Reserves, and customary forms of tenure now have statutory recognition and continuation. Although there are calls for the establishment of a land use commission in Zambia, there is currently no comprehensive land use policy.

Zambia's industrial sector has long been focused on mining, which contributes a quarter of GDP. Current industrial policies, while continuing to place great emphasis on the privatisation and increased efficiency of the mining sector, also contain a focus on developing manufacturing, especially for export and by the private sector.

The National Water Policy of 1994 is focused on improving the access of both urban and rural populations to clean water and sanitation services. The government has developed a national water strategy that will encompass rural and urban water supplies, river basin management, irrigation, and the control of pollution. It deals with the strengthening of urban water management, rehabilitating water supply and sewage treatment facilities, and increasing fees and improving fee collection so as to generate the funds necessary to operate the water systems on a more commercial basis.

In the power sector, the government's main priorities, as laid out in the 1995 Energy Policy, are to privatise state enterprises, facilitate private sector investment, rationalise energy prices, and to develop new sources of energy – especially hydropower. To facilitate private sector involvement in new generation and transmission projects, a hydropower and transmission policy was approved by the government in October 1998 that will make it possible to develop new projects

The 1990 framework Environmental Protection and Pollution Control Act is concerned almost entirely with urban and industrial pollution. The 1994 National Environmental Action Plan, sets out environmental priorities and a framework for their implementation. It highlights five major environmental issues that need to be addressed: soil degradation, water pollution and inadequate sanitation, deforestation, air pollution, and wildlife depletion. To deal with these issues, the government is undertaking an Environmental Support Program (ESP), which is the first step of a long-term effort to strengthen environmental capacities. The ESP aims to strengthen the institutional and regulatory framework for environmental protection and natural resources management, and to enable communities to address the degradation of natural resources. The 1993 Wildlife Policy and draft National Forest Policy operationalise these goals as they relate to the national forest and wildlife estate. Both place emphasis on the need to promote sustainable utilisation of wildlife and forest resources, and have as goals to expand the role of local communities and the private sector in resource management, at the same time as maintaining the integrity of protected areas and conserving key natural resources for the benefit of Zambia's population. The 1997 Tourism Policy aims to develop a sustainable market-oriented private-sector tourism industry which is sensitive to community needs, whilst ensuring the preservation of environmental and cultural integrity. The primary objective of the policy is to create an economically and environmentally sustainable sector. Zambia is currently in the process of developing a National Wetlands Policy.

8.3.2 Namibia

Since Independence in 1990, Namibia has had as its central development goal to alleviate social and economic inequities through a programme of sustained economic growth. Although the government has continued to play a strong role in the economy, and Namibian macroeconomic policy is still strongly influenced by developments in South Africa, the First National Development Plan (covering the period 1995/6-1999/2000) sets in place a programme of economic and market reforms. In late 1997 a package of austerity measures was approved, and macroeconomic policy has included as major strategies the rationalisation of the public sector, strengthening capacity for macroeconomic management and formulating a long-term development strategy where the private sector is to be the major engine for growth. Tools include the liberalisation of most market prices, strengthening of the tax administration, fiscal reforms, public expenditure cuts, restructuring of public enterprises and the development and diversification of the export base.

Although the Namibian economy is dominated by the mining sector, agriculture – mainly cattle and ranching – and fishing activities are also important, and provide a major source of income and employment for the majority of the population. Both are characterised by a dual structure, with commercial and subsistence sub-sectors. In support of macroeconomic goals of food self-sufficiency and export promotion, both commercial and subsistence activities in these sectors have a long history of subsidies, and the ranching sector is still protected in comparison to other sectors of the economy. Key aspects of the current 1995 Agricultural Policy include concentrating resources on the production of grain and beef, increasing the integration of communal farmers into domestic and export markets, phasing out subsidies, increasing private sector participation in agricultural production and marketing, and promoting sustainable land and natural resource management.

Land in Namibia is divided into commercial areas, owned by individuals under freehold title, and communal lands, owned by the state. Nambia's pre-Independence policies on communal and commercial lands have however been substantially reformed, decentralised and made more equitable over recent years. Resettlement of communal landholders into former commercial lands has also been a major policy strategy, as has the creation of capacity and requirements for integrated land-use planning. Goals of sustainable resource use and management are laid out in the 1994 Policy Document on Land-Use Planning.

Policy in the water sector is focused on the expansion and development of water supplies for domestic use, mining, ranching and irrigation, and water provision remains heavily subsidised, including water for commercial uses. Moves are however underway to establish a more rational and economic pricing structure for water and to promote the "proper" use of scarce water.

Environment and natural resource policies deal explicitly with natural resources on communal lands, and on involving local residents in the management and utilisation of resources. The 1992 Forestry Policy, although maintaining state ownership of trees and forest resources on communal lands, contains strong provisions promoting both the sustainable utilisation of natural resources and the participation of rural communities in forestry activities. Wildlife policy, including the 1994 Policy Document on Wildlife in Communal Areas, is also focused on the devolution of use and management rights, and on the sustainable utilisation of wildlife for economic gain. The 1994 Policy Document on the Conservation of Biotic Diversity and Habitat Protection also refers to the sustainable utilisation of resources for economic gain, especially in communal areas. The 1994 White Paper on Tourism is concerned with the interests of, and social impacts on, communities, the reinvestment of tourism gains into tourism and the environment, and the co-ordination of public and private sector goals. Local community involvement in tourism development will be promoted, while the utilisation of natural resources (hunting, agricultural, etc.) will be kept within sustainable limits and the creation of private conservation areas will be encouraged through the use of incentives. The 1998 draft Environmental Management Act, although it contains strong goals of community involvement and benefit, is mainly concerned with setting out the institutional arrangements and functions of the Sustainable Development Commission, the requirements for environmental impact assessment and the nature of environmental offences and penalties.

8.3.3 Malawi

The government of Malawi has been pursuing a series of economic reforms and adjustments since the early 1980s, although these have gained impetus only since the first democratic elections were held in 1994. Initially, implementation of such policies led to major successes in both macroeconomic management and structural reform. However, in 1997, the pace of structural reform slowed. Since 1998 the government has made a renewed effort to reinstate a process of structural reform. The government's medium-term development strategy seeks to alleviate poverty through accelerated growth, restoration of financial stability, and increased access to basic social services. This is to be achieved through cutting back both public spending and civil service staffing; through the privatisation of state-owned enterprises; through price, market, trade and exchange rate liberalisation; and through a series of fiscal reforms. In addition, the government has instituted a Poverty Alleviation Program which provides for targeted interventions to benefit the poor, while developing safety nets to address the needs of vulnerable groups.

Malawi’s economy is heavily dependent on agriculture, which contributes over 38% of GDP, supports 90% of the population, and provides the main export earnings. Agricultural policy, as laid out in the 1995 Agricultural and Livestock Development Strategy and Action Plan, is focused on expanding both crop area and diversity as a means of strengthening food security, export earnings, income and employment. Structural reform of the agricultural sector, including privatisation, market and price reform, is a central element in the country’s medium-term strategy. Within the agricultural sector, irrigated production is seen as a key area for future growth, and is actively promoted in the 1997 Draft Irrigation Policy and Development Strategy. Fisheries also form an important component of the economy. The primary focus of fisheries policy is however on the development of commercial rather than subsistence activities, through the expansion of fishing area, increase of catches and establishment of aquaculture.

Land in Malawi is held under a variety of categories, including customary lands (which are held in trust through Chiefs), privately-held leasehold land, tradable registered land, freehold land and public land. Land policy and legislation are currently under review, under the Presidential Commission of Enquiry on Land Policy Reform. The main goals of current land policy are to reduce rural poverty through agricultural land reform, and the development of land allocation procedures and markets. Little reference is made to sustainable land management, and there is currently no integrated land use policy in Malawi.

Although industrial activities contributes less than a fifth of to Malawi's GDP, they are seen as a key area for future economic growth. Here, the policy focus is on expanding and diversifying non-agricultural sectors of the economy, including manufacturing, and privatising and divesting state assets.

Water policy in Malawi is mainly concerned with regulating quality and abstraction, and with providing clean water supplies to urban and rural households. In order to achieve the main policy goals of improved water supply management, the government is pursuing strategies of infrastructural expansion and rehabilitation, increased decentralisation, privatisation and community-based water supply management, and the introduction of economic water pricing structures. In the power sector, the Electricity Act of 1998 lays the groundwork for initiating private investment in power generation, transmission and distribution. The government is also pursuing several alternative sources of energy, with a strong focus on various options for hydropower development, including interconnection with Cahora Bassa in Mozambique.

The 1994 National Tourism Policy aims to optimise the contribution of the tourism industry to national income, employment and foreign exchange earnings through the creation of a favourable environment for private sector involvement in the industry, community participation. It also aims to enhance the role of the public sector in facilitating sustainable tourism development. The policy includes taking cognisance of environmental and cultural values and ensuring that the country's tourist attractions, i.e. natural and cultural heritage, are protected. There is a recognition that ecotourism is the basis of the tourism industry in Malawi.

Since adopting the National Environment Policy (NEP) in 1996 and passing the Environmental Management Act in June 1996, the government has been implementing the NEP program. Over the next three years it plans to implement regulations, established in 1997, guiding the use of environmental impact assessment for certain categories of private and public investments; to adopt policies for local community benefit-sharing; rationalise water pricing; strengthen the regulation of industrial pollution; and continue support for investment by sectoral ministries and local communities to address priority environmental issues.

While environmental policy presents an overall framework, on-the-ground species and ecosystem conservation is mainly dealt with in forestry and wildlife policies in Malawi. While still containing a strong focus on the conditions under which protected areas are established and run, both the Draft Forestry and Wildlife Policies make repeated reference to the need to ensure that resources outside protected areas are conserved, and accord both local communities and the private sector a much greater role in this. The Draft Wildlife Policy of 1997 contains explicit reference to wetlands.

8.3.4 Mozambique

While Mozambique launched a structural adjustment program in 1987, major economic reforms have only been implemented since the first national elections were held in 1995. An ambitious programme of structural reforms was undertaken between 1996-98 period, including the privatisation of formerly state-owned enterprises, civil service reform, and agricultural and trade liberalisation. Economic objectives for the period to 2002 include to strengthen the foundations for real GDP growth, limit inflation, and maintain international reserves. Sustained, broad-based real GDP growth and low inflation, together with improved delivery of social services, are central to the government's efforts to reduce poverty in the medium term. To attain these objectives, the government is committed to maintaining financial discipline, improving the environment for the expansion of private sector activities, and fostering the development of a strong export base through liberal trade and investment policies, while reducing the dependence on foreign aid.

Agriculture forms a major component of Mozambique's national economy, contributing 34% to GDP and providing the country's major export earnings. The 1995 Agricultural Policy focuses on the development of the agricultural sector for food security and export promotion. In 1999, the government started implementation of a five-year agricultural sector expenditure program (PROAGRI), aiming to stimulate crop production and exports, rationalise public expenditure, further liberalise and improve agricultural input markets. A strategy for fisheries development is laid out in the 1996 Fisheries Policy which, although concentrating on both artisanal and large-scale fisheries activities, is mainly focused on expanding catch at the same time as specifying the licensing arrangements and areas of operation for fishing activities.

Land policy in Mozambique relies on the Land Policy of 1995. These have as their goals to adopt and enforce land tenure regulations, and especially to improve land tenure security in the smallholder sector. A variety of strategies, based on the decentralisation of land administration, the divestiture of state landholdings and the recognition of customary forms of tenure, aim to achieve these goals. The Land Law of 1997 simultaneously provides for the creation of protected areas and recognises the right of local communities over land and natural resources, and also establishes a National Land Cadastre to compile data on different land uses and to organise land use, protection and conservation.

A National Water Policy for Mozambique was approved in 1995. Under this policy, the government aims to facilitate the access of businesses and households to water, and is undertaking a broad reform of water supply provision aimed at moving toward delegated management, and improving its regulation and financial planning. In December 1998, the legal framework for private sector participation, a regulatory board for water, and a water tariff policy were all approved. It has also begun implementation of a Rural Water Transition Plan, which aims at promoting community management, cost recovery, and the involvement of the private sector in water supply management. The government has also committed itself to developing a national water resource management strategy and a strategy for internationally-shared river basins, and it will develop and implement riparian co-operative legal and institutional frameworks at the regional level.

The government has stated that it will, by December 1999, adopt regulations to implement the Electricity Law promulgated in 1997. The law sets a framework for expanding and improving the provision of electricity services through competition in the generation and distribution of electricity. In addition to setting new tariff and management structures, strategies for energy development include a focus on improving the efficiency and utilisation of biomass fuel sources and the expansion of the country's hydropower reserves, which are seen as having great potential for future growth.

The 1995 National Tourism Policy states that tourism should be seen as a priority sector that will contribute to the reconstruction and development of the country. The policy promotes the protection of strategic tourism areas in order to sustain tourism benefits. The Environmental Law of 1997 aims to promote the sustainable use of natural resources by adopting regulations on environmental impact assessment, environmental management, waste management and marine pollution and by establishing and maintaining protected areas. However, it deals mainly with environmental management in the industrial and urban sectors. In Mozambique there is a single policy document dealing with forestry and wildlife – the 1997 Policy and Strategy of the Department of Forestry and Wildlife. This focuses on expanding and maintaining the integrity of the national wildlife and forestry estate, while continuing to sustainably develop it for commercial and tourism purposes as well as for community benefit.

8.3.5 International agreements and conventions

The Regional Strategic Action Plan for Integrated Water Resources Development and Management in the SADC Countries (1999-2004) recognises the importance of harnessing water resources for development in the region, but at the same time recognises the instream values of water resources and the need for a regional approach to sustainable water resources management. What is needed is the development for sound methods of taking ecological considerations and economic trade-offs into account in water resource planning, as is being pioneered in South Africa. The development of such protocols is missing from the Action Plan.

The main regional instruments relating to wetland management are the Zambezi Action Plan (ZACPLAN, 1987) and SADC Protocol for the Zambezi Basin (1995). Malawi, Mozambique and Zambia are all signatories to these instruments. The main purpose of ZACPLAN is to develop regional co-operation on the environmentally sound management of water resources of the Zambezi system and to strengthen regional collaboration for sustainable development. The Zambezie River Basin Water Commission (ZAMCOM) is a proposed agreement between all the SADC countries on the formation of a permanent Zambezi river basin water commission. In addition Zambia has, with Zimbabwe, established supportive legislation to the Zambezi River Authority (ZRA). The ZRA is jointly owned by the governments of Zambia and Zimbabwe in equal proportions. The ZRA is in the process of drafting an Environmental Policy and Strategy for the Zambezi River. In this policy, the ZRA is obliged to define environmental and sustainability indicators, and to prepare and implement strategic plans to meet the objectives identified in treaties and conventions such as those listed below. It includes commitments to the use of environmental impact assessment, biodiverstiy conservation, and gender equality.

Malawi, Mozambique, Namibia and Zambia have ratified a number of international conventions relating to wetland issues and management. All these conventions depend for their implementation on the establishment of laws and other regulations at the national level, and include the Ramsar Convention (1971), the Convention on Biological Diversity (1995), the Convention on International Plant Protection, the Convention on International Trade in Endangered Species (1971) and the African Convention on Conservation of Nature and Natural Resources.

All the study countries have prepared, or are in the final stages of preparing, National Biodiversity Strategies and Action Plans as part of their obligations under Article 6a of the Convention on Biological Diversity. These strategies and action plans all contain detailed consideration of wetlands – as well as presenting in-depth information about the ecological and biological status of wetlands, as part of national biodiversity assessments or country studies, a series of strategies and actions for wetland conservation, sustainable use and equitable benefit-sharing have been laid out. These actions are however yet to be implemented in any of the Zambezi Basin countries.

8.4 POLICY INFLUENCES ON WETLAND STATUS

8.4.1 Policy causes of wetland degradation and loss

Although not the main cause of wetland loss, policies in the natural resource and environmental sectors have at best failed to balance or halt wetland degradation and at worst may have exacerbated it. Despite the fact that environmental, forestry and wildlife policies in all of the Zambezi Basin states have as their goal the conservation of natural species and ecosystems, the implementation of measures to achieve these aims has tended to have been ineffective in practice, and supportive regulations and other instruments have been poorly enforced. Until the reform of environment, forestry and wildlife sector policies over the last few years (mainly as part of National Environmental Action Plan processes, and more recently in line with Biodiversity Strategy and Action Plans), the need for some degree of community participation in resource management or for the sustainable utilisation of wild resources have also been largely ignored in wildlife and forestry policy. Because of these weak policies, destructive uses of wetland areas and resources have tended to be more economically attractive to adjacent residents, as compared to conservation, and have often been an economic necessity. Most natural resource and environmental sector policies have also, until recently, failed to mention wetlands and have instead focused almost wholly on upland habitats.

The underlying economic causes of wetlands degradation are however mainly found outside the natural resource and environmental sectors, in the "productive" sectors of the economy. Sectoral policies have provided the main stimulus for wetland degradation, in turn exacerbated by macro-policy frameworks that emphasise as key areas for growth those activities and sectors that have the most potential to impact negatively on wetlands. As described below, policies in the agricultural, fisheries, industrial, energy and water sectors give particular cause for concern and have the main potential to encourage wetlands conversion, unsustainable resource utilisation and alteration of hydrology and water quality.

8.4.1.1 <u>Unsustainable exploitation</u>

A variety of policy forces have led to the unsustainable exploitation of wetland resources. Generally unstable macroeconomic conditions, including a history of economic mismanagement before and after independence and, since the early 1990s, economic austerity, stabilisation and adjustment measures, have resulted in widescale rural poverty, unemployment and weakened rural livelihood bases in all of the Zambezi Basin countries. These conditions have been exacerbated by recurrent drought and political disruptions over the last decade, including severe civil unrest in Namibia and Mozambique. Together, the national and local-level economic instability resulting from these macro policy forces has led to a situation where the exploitation of wetland resources, often at unsustainable levels, has provided the only easily accessible source of income and subsistence for many of the households living in the Zambezi Basin. In particular, the utilisation of wetland resources often provides the only safety net at times of stress, for poorer households and for more vulnerable social groups – such as women, the landless and the unemployed. Macro-economic policies have also resulted in poor markets and distorted prices, which can further encourage unsustainable exploitation.

Within this macro context, fisheries policy has also failed to check the decline of wetland resources by either local communities or commercial users. In both Malawi and Zambia there is virtually no reference to small-scale fisheries in sectoral policies. This omission has meant that there is little consideration of the sustainability of wetland fisheries activities. Even where fisheries policy includes strategies relating to artisanal-level activities – such as in Mozambique and Namibia – the overall focus is on expanding fisheries catch and commercialisation. Although fisheries policies have set in place restrictions on licensing, fishing gear, methods and species, fishing seasons, there is almost a complete absence of effective control on effort and the use of harmful gear. In none of the Zambezi Basin countries does fisheries policy recognise the important role of wetlands in maintaining productivity and stocks, or make any attempt to conserve these functions and resources, through promotion of protected areas.

Because there are no wetlands policies, or specific institutions for their management, the responsibility for non-fish wetland resources are highly fragmented. These resources, including grasslands, reeds and other aquatic plant and animal species are omitted altogether from policy. Although sectoral policies exist for forestry and wildlife in all of the Zambezi Basin countries, and are concerned with the protection of wild species and ecosystems, they contain virtually no specific reference to wetlands. Wetland plant and animal species mainly lie outside their scope and outside the jurisdiction of the institutions who manage them. There are few checks on utilisation, or attempts at the conservation of wetland resources. Part of this problem lies in the fact that there is poor community or private sector participation in the conservation and management of wetland resources, due to emphasis on state control of natural resource use. There is a lack of finance for conservation and a lack of livelihood and business concerns in conservation.

Other sectoral policies that affect resource utilisation, such as those relating to energy and water, also pay little attention to wetlands. There is a general lack of consideration of proper impact assessment in policies relating to the agricultural, industrial, water and energy sectors.

8.4.1.2 Wetlands conversion to agriculture

In most of the study wetlands, destructive impacts have arisen from agricultural sector activities. This is also due, in part, to the lack of wetlands policy. Sectoral policies relating to crop production have provided a major stimulus for wetland conversion, driven by the focus on agriculture as a key national growth sector and promotion of smallholder self-sufficiency. There has been widescale modification of wetlands to agriculture, including maize, rice and sugar cane. This has been encouraged directly by agricultural sector policies, including an overriding focus on the expansion of arable agriculture, especially under irrigated conditions, usually in the absence of any controls and almost always without consideration of impacts on wetland hydrology and ecology. In turn, the expansion of arable crops and area has been stimulated by the use of various economic instruments such as subsidies to agricultural inputs and water, controlled prices and markets. Although, under on-going economic reform processes, many of these controls have been dismantled and prices rationalised, as economies and markets have been liberalised, the agricultural sector remains heavily protected compared to other sectors of the economy in all of the Zambezi basin states. The lack of any coherent land use policy, and the poor scope and enforcement of EIA requirements on agricultural land uses, have also exacerbated these trends.

8.4.1.3 Alteration of hydrology and water quality

Policies in the industrial, water, agriculture and energy sectors all have major impacts on the hydrology and water quality of the Zambezi Basin wetlands. Effluents from urban industries, and to a lesser extent commercial agriculture, have already altered significantly the quality of water entering the Shire wetlands in Malawi and may in the future affect the wetlands in other study sites. In none of these sectors are there proper controls on development or waste disposal, and EIA guidelines tend to be both poorly-enforced and to be weak in their coverage of wetland areas and species. While water policy focuses on water quality and supply, this is limited to domestic and industrial water abstraction and use. There is little consideration of maintaining the water quality of aquatic ecosystems.

There is also little mention of the impacts of developments which alter downstream water hydrology. Of greatest concern is macroeconomic and sectoral policy focus on expanding hydroelectric power supply and water supply infrastructure, and the use of river water for irrigation schemes. In addition, existing and proposed measures to regulate flooding of wetland areas to minimise damage to smallholder and irrigated agricultural schemes threaten their ecological integrity.

8.4.2 Policy support to wetland conservation

Environment and natural resource policies provide a potentially strong source of support for wetland conservation. Wildlife, forestry, environment, tourism and natural resources policies all have the stated aim of conserving wild species and ecosystems, and are concerned with setting in place the institutional, legal, land use and market mechanisms necessary to achieve this. Today there is less focus on strict protection in these policies, although it should be recognised that strict protection still plays a vital role in biodiverstiy conservation. There is now an increasing focus on conserving biodiversity outside traditional protected areas – such as wetlands – and raising the degree to which local communities benefit from, and sustainably use, natural resources. Policy has thus moved its focus to management regimes that emphasise sustainable utilisation, equitable benefit sharing, and an increased role for civil society in resource management.

Environmental and natural resource policy, as well as setting in place these general enabling conditions for wetland conservation, also provide some protection against the negative impacts associated with agricultural, urban and industrial developments. In each of the Zambezi Basin states, umbrella environmental policies set a framework of regulations and standards for land use, discharges and water quality. They also specify instruments for their enforcement, including EIA, fines, penalties and charges. However, such policy specifications need to be accompanied by more effective on-the-ground action. Control is currently poor in all the study areas, and policy makers and regulators are insufficiently knowledgeable about field conditions.

Certain elements of non-environmental policies provide indirect support to wetland conservation. For example, in all the countries, macroeconomic policy contains the stated aim of ensuring that economic development is sustainable. Increasing deregulation, privatisation and devolution of the state's role in the economy and in resource management also provide opportunities for increasing local participation and gain from wetland management. Macro and sectoral policy goals aimed at improving rural livelihood diversification, food security, income and employment all provide a means of lessening community reliance on wetlands resources and minimising unsustainable utilisation. Policies in sectors dealing with the utilisation of wetlands and their resources – such as fisheries, forestry, energy, tourism and agriculture – all contain, to varying degrees, some recognition of the need to promote sustainable and efficient harvesting and land use practices, and to regulate destructive or unsustainable utilisation and technologies.

8.4.3 Gender issues

In general there is little mention on gender issues in country policies relating to wetlands. Although Zambia is in the process of developing a policy on gender, and in all countries there are government institutions mandated to address matters relating to gender equality (alongside other related issues), these matters tend to be dealt with separately from issues of resource use, ownership and management. An exception is the ZRA draft environmental policy. This expresses a belief in the equitable access to natural resources by both men and women, and accepts women as managers and protectors of these resources.

Gender is, however, an issue that is central to the management of the Zambezi wetlands. Many of the rural households located around the wetlands are, *de facto* or *de jure*, female headed. In all of the countries under question, and especially in Namibia and Zambia, there is a high rate of male out-migration, and many men are resident for long periods outside the wetland area because they work in towns and urban centres. Women make many of the day-to-day decisions about household production and consumption, and rely directly on wetland resources to support family livelihoods. This dependence, coupled with the fact that women are often among the most economically marginalised sectors of society, mean that that they often stand to lose most when wetlands are degraded, or are converted to more commercial uses (such as irrigated agriculture) - because men typically take control of such cash-based activities.

Gender is also an issue in the management and control over wetland resources. Although, as mentioned above, it is women who make many of the day-to-day decisions concerning wetland use and management, it is almost exclusively men who have property rights over land and resources, and who make the ultimate decisions about them at household and village levels. Despite their reliance on wetland resources, and their day-to-day interactions with them, women are rarely formal decision-makers when it comes to their use and management. There is also, among all of the wetland communities under study, a gender division of wetland labour. Typically, men control the higher-value, cash income-generating activities, while women deal more with wetland resource utilisation activities that generate basic household subsistence. Any change in wetland use, management or status thus has the potential to impact on this division of labour, as well as on access to and control of productive resources and cash income.

In addition, there is increasing concern in the literature about the influence of women's education and economic empowerment on choices about family size. The general thesis is that improvements in these conditions lead to smaller families and may therefore help to combat excessive population growth and pressure on natural and other resources. The latter is critical to achieving long-term sustainability of scarce resources in the Zambezi basin.

8.4.4 Likely scenarios under current policy trends

Under existing policies, it is most likely that the wetlands of the Zambezi Basin will continue to be degraded in the future. The positive incentives for wetland conservation and disincentives to wetland degradation that are found within current policy are outweighed by the negative policy forces which encourage economic activities to take place in ways, and at levels, that lead to wetland loss. The over-exploitation of wetland resources is likely to escalate throughout the Basin. In at least two of the study sites – Zambia and Malawi – conversion of wetlands to smallholder irrigation schemes and to large-scale commercial agriculture is continuing to be promoted in support of agricultural policy goals.

Agricultural conversion is a particular threat in the Lower Shire and is also a real threat in the Barotse and Delta wetlands, and is a possibility in Caprivi. The Lower Shire wetlands in Malawi are likely to suffer increasingly from the impacts of upstream pollution. Strict protection of whole wetlands in the Zambezi Basin is unlikely. As well as incurring high economic opportunity costs, it is not a management regime that is favoured by current policies in natural resource and environmental sectors. There do exist policy elements that could be used to promote the wise use and conservation of wetlands, and these could promote protected areas within the wetlands for the conservation of biodiversity. However, existing market, economic and financial instruments are insufficient to encourage the establishment of protected areas.

8.5 ECONOMIC CONDITIONS AND INSTRUMENTS FOR WISE AND SUSTAINABLE USE OF WETLANDS

It is clear that, to achieve the wise use and sustainable management of the Zambezi wetlands, there will have to be a change in the economic and policy conditions under which they are used and managed. This means taking action at three major levels:

- Overcoming and dismantling the perverse incentives and disincentives in existing policies that encourage wetland degradation;
- Using economic instruments to reinforce existing incentives for wetland conservation;
- Setting in place additional positive economic incentives for wetland wise use and sustainable management, and economic disincentives against wetland degradation, and ensuring that these are targeted at the groups and sectors whose actions have the potential to impact on wetland status.

A wide range of economic instruments can be used to support wetland wise use and sustainable management (Table 8.4.1). In the context of the Zambezi Basin wetlands, particular consideration should be given to the following issues:

Broader community goals and existing local organisation: As far as possible, the design and choice of incentive measures for wetland conservation should simultaneously meet community needs, aspirations and goals, strengthen livelihoods, and work through existing local institutions and knowledge to reach their aims. This will significantly enhance community compliance, local effectiveness and acceptability.

Incentive measures should not make any community members worse off: Any incentive package which raises the price of basic subsistence items, decreases local employment or income opportunities or marginalises particular sectors of the community is unlikely to be acceptable or sustainable.

Incentive measures need to be acceptable to politicians and decision-makers, and consistent with wider development and conservation goals: Any measure which conflicts with macroeconomic or sectoral political, social or economic goals is unlikely to be implementable in practice. The aim of using economic incentives for wetland management in the Zambezi Basin is to support conservation and development, not to contradict their aims and approaches.

Incentive measures should be easy to implement, and minimise transaction, enforcement and participation costs: Even if they are externally supported (for example by the ZBWCRUP), incentive measures will ultimately be maintained through the actions of government and local communities. They should be easy and cheap to implement for all groups concerned if they are to be sustainable over the long-term.

Table 8.4.1. Summary of economic instruments and conditions required for wetlands wise use and sustainable management

Existing	**Required**		
Policy climate	**Policy conditions**	**Market conditions**	**Supportive economic instruments**
Considerations of sustainability in resource and land uses	Recognition of need to make sustainable land and resource uses profitable	Prices and profits from land and resource uses reflect full values, and externalities, associated with wetland impacts	Differential land and product taxes Dismantling of subsidies Grants and loans to sustainable resource and land use development Fines and penalties
Provisions for community benefit sharing and participation in management	Recognition of need to generate tangible local economic benefits and offset opportunity costs	Community access to finance and markets	Direct revenue-sharing Micro-enterprise development Property rights in land and resources New markets and charges Grants and loans to alternative enterprises
Inadequate funding for wetlands management	Integration of innovative funding mechanisms	Market opportunities and profits accrue to wetland cost-bearers	Property rights in land and resources New markets and charges Establishment of funding mechanisms Commercialisation of wetland management User fees Fiscal instruments Joint ventures, franchises, leases and concessions Private investment, sponsorship and donations Innovative international mechanisms
Distorted or non-existent markets in sustainable wetland goods and services	Dismantling of distortions, rationalisation of markets and prices	Improved prices and markets that reflect full values, and externalities, associated with wetland impacts	New markets and charges in wetland goods and services Dismantling of subsidies Differential product taxes
Absence of alternative livelihoods	Recognition of need to provide livelihood alternatives to destructive land and resource uses	Community access to finance and markets in alternative products and livelihoods	Micro-enterprise development New markets and charges in wetland goods and services Grants and loans to alternative enterprises
Poor appreciation of wetland values in development and land use planning, and in sectoral policy goals	Integration of policy goals geared at conservation, recognition of wetland economic values, dismantling of perverse incentives and replacement with positive incentives	Wetland full values and externalities reflected in prices and markets for wetland and other products	Demonstration of wetlands values Differential land and product taxes Dismantling of subsidies Markets and charges
Weakly enforced controls on commercial and industrial developments, regulations and standards	Provision of disincentives/incentives to conform to regulations, standards and controls	Prices and profits of inputs and products reflect full values, and externalities, associated with wetland impacts	Deposit and restoration bonds Fines and penalties Differential land and product taxes Pollution and effluent charges Grants and loans to clean technologies

8.6 DEVELOPMENT OF WETLANDS POLICIES IN THE ZAMBEZI BASIN STATES

8.6.1 Background to wetland policy formation

Very few African states, indeed very few countries globally, have a wetland policy. Uganda was the first country in sub-Saharan Africa to develop a wetlands policy, adopted in 1995. To date, the only other countries with a wetland policy are Australia, Canada and Costa Rica. Among the Zambezi basin states, Zambia is currently in the process of developing a national wetlands policy.

The 7th meeting of the Conference of the Parties to the Ramsar Convention, held in Costa Rica in May 1999, urged countries to develop their own national policies on wetlands, and provided guidelines on this (see Box 8.1).

These guidelines provide a useful basis for the development of wetlands policies in Zambezi Basin states. It is also worth noting that the development and adoption of economic incentives for wetlands conservation has also been prioritised by the Parties to Ramsar, and is included in current programmes of work.

Several useful lessons learned also arise from the experiences of Uganda, which have great relevance for Zambezi states, as well as other habitat-centred policy formation in other countries (e.g. the development of coastal policy in South Africa):

8.6.1.1 Level of policy formulation

Wetlands policies must be country-driven, because it is at this level that they will be implemented. Although regional agreements provide a useful framework for common action, it is at the national level that policies operate.

8.6.1.2 Approach to policy development

Of over arching importance is the need for national wetlands policies to be based on a broad consultative process. Wetlands policies cannot be prescribed externally, or by a single "expert" group. They must arise as part of a process that is nationally-driven and carried out.

In many countries, past experience has shown that prescriptive and control-based approaches to policy implementation are far less likely to be effective than facilitative approaches. Broad principles are recognised, goals and objectives are set, and mechanisms are established to facilitate detailed planning and implementation at lower levels of government. It is essential to create mechanisms for effective participation by the full range of stakeholders involved. Part of this process will involve the education of stakeholders. For policy to be effective, it should emphasise the economic and social benefits that can be derived from wetlands, as well as the need to protect the wetland ecosystems upon which those benefits depend. Policy also needs to ensure that the needs of all components of the affected communities are addressed.

Box 8.1 Ramsar Guidelines for developing and implementing National Wetland Policies

1. RECALLING Article 3.1 of the Convention, which states that Contracting Parties "shall formulate and implement their planning so as to promote the conservation of the wetlands included in the List, and as far as possible the wise use of wetlands in their territory";
2. FURTHER RECALLING Recommendation 4.10 and Resolution 5.6, and their annexes, which provide Guidelines for the implementation of the wise use concept and Additional guidance for the implementation of the wise use concept respectively, and, in particular, urged Contracting Parties to develop and apply National Wetland Policies as an important step towards achieving the wise use of wetlands;
3. AWARE that Recommendation 6.9 called for the production of a framework for developing and implementing National Wetland Policies and an analysis of the status of wetland policies worldwide;
4. ALSO AWARE that Operational Objective 2.1, Action 2.1.2, of the Strategic Plan 1997-2002 urged Contracting Parties, the Ramsar Bureau, and Partner Organizations to "promote much greater efforts to develop national wetland policies, either separately or as a clearly identifiable component of other national conservation planning initiatives";
5. NOTING WITH PLEASURE the advice given in the National Reports to this Conference of the Contracting Parties that 77 Parties have National Wetland Policies or Strategies in place or under development;
6. FURTHER NOTING that Technical Session II of this Conference, on National Planning for Wetland Conservation and Wise Use, had presented to it and considered in detail the annex to this decision entitled Guidelines for developing and implementing National Wetland Policies;
7. RECOGNIZING that the development of policies and related initiatives may require efforts to build capacity where human, technical and financial resources need to be augmented; and
8. EXPRESSING ITS THANKS to the authors of the annex to this Resolution for providing their combined advice, based on experience, so that Contracting Parties preparing or considering the preparation of such Policies can finalise or undertake the task with improved efficiency and effectiveness;

THE CONFERENCE OF THE CONTRACTING PARTIES

9. ADOPTS as guidance for the Contracting Parties the annex to this Resolution entitled Guidelines for developing and implementing National Wetland Policies and URGES those Parties that have yet to develop such Policies to give this activity their highest attention;
10. URGES Contracting Parties to note and apply with equal vigour the related guidance provided as an annex to Resolution VII.7, Guidelines for reviewing laws and institutions to promote the conservation and wise use of wetlands, aware of the close relationship between policy instruments and legislation;
11. ENCOURAGES Contracting Parties to recognise the benefits of incorporating into National Wetland Policies appropriate measures to ensure that wetland restoration is given priority consideration in the administration of programmes and government expenditure, and in the promotion of local actions to rehabilitate degraded wetlands;
12. ALSO ENCOURAGES Contracting Parties to integrate into their National Wetland Policies, wherever possible, the elements of the other guidance adopted under the Convention such the Guidelines for the implementation of the wise use concept (Recommendation 4.10) and Additional guidance for the implementatioin of the wise use concept (Resolution 5.6), the Guidelines for management planning for Ramsar sites and other wetlands (Resolution 5.7), the Guidelines for international cooperation under the Ramsar Convention (Resolution VII.19), and the Convention's Outreach Programme (Resolution VII.9), having regard also to Resolutions VII.16 on impact assessment and VII.15 on incentives; and
13 FURTHER URGES, in accordance with the Guidelines for international cooperation under the Ramsar Convention (Resolution VII.19), Contracting Parties with experience in the development and implementation of National Wetland Policies to promote opportunities for the sharing of this knowledge and experience with other Ramsar Parties initiating such a process.

8.6.1.3 Scope of policy

It is important that a wetlands policy maintains a strategic focus. The policy has to be selective about which issues to address. Issues that can be addressed include water quality, biodiversity, fisheries, agriculture, and others, many or all of which are the focus of other sectoral policies. When dealing with natural environments such as wetlands, one of the priorities is often the provision of basic needs. This is covered in other polices too, but it is important that wetlands policy addresses developmental issues.

Nevertheless, as well as developing national policies specifically concerned with wetlands, it is of paramount importance to work on integrating wetlands concerns into other sectoral policies, especially those dealing with environmental management and impact assessment, and with the "productive' sectors of the economy whose activities impact on wetlands or rely on wetland goods and services

It is important to integrate all of ecological, hydrological, social and development goals into national wetlands policies

8.6.1.4 Defining and delineating wetlands

Defining wetlands and delineating their boundaries are usually problematic and controversial in the case of wetlands. There are no set rules for this which can be applied without some level of subjectivity. It is not always ideal to delineate wetland boundaries on the basis of scientific approaches alone. It is important to consider the social context of each wetland, taking into account the extent to which communities in and around wetland areas interact with these habitats. Once goals are set, policymakers can identify the resources that should be managed, and distinguish the appropriate area in which policy and regulation are to be implemented.

8.6.1.5 Institutional arrangements

It is important to ensure that adequate institutional arrangements are made for wetlands management, alongside policy development. This includes specifying an adequate funding mechanism and funding base for national wetlands management. It also requires the development of legal guidelines and mechanisms for the implementation and enforcement of wetlands management goals. Choices need to be made as to the exact powers and functions of different spheres of government, including national, provincial and local bodies. Devolution of powers and functions is a key strategic issue.

The location of the lead agency for wetlands management may be in government departments such as environment departments, preferably existing departments. It is also important to develop co-ordinating mechanisms to strengthen inter-agency collaboration. At the local level, there would need to be the development of local management committees.

8.6.1.6 Instruments for implementation

There are a number of strategic choices that need to be made, pertaining to the instruments to use in implementing wetlands policy. These include:

- Legislation and regulations (e.g. permits, quotas)
- Economic instruments (incentives, taxes, subsidies)
- Direct development (e.g. wetland rehabilitation, launching facilities)
- Education and training (to encourage participation and compliance)
- Research and monitoring (to identify problems and successes)
- Changes in governance procedures (e.g. new structures)
- Conflict resolution mechanisms (e.g. procedures for challenging allocation decisions)
- Participation of user groups (e.g. in management action)

8.6.1.7 Monitoring and review.

Consideration needs to be given to ensuring the continuous improvement of wetlands policy and its implementation. Thus allowance should be made for regular review and readjustment through monitoring and evaluation mechanisms. These activities should involve scientists, sociologists and economists as well as the stakeholders themselves. It is necessary to define performance criteria against which to measure the success of policy objectives.

8.6.2 Vision and principles of a wetlands policy

A vision statement, which provides a clear statement of intent for the policy, is usually developed in consultation with stakeholders. A vision for wetlands management within the Zambezi Basin countries might incorporate something like the following:

"*Our vision is to guide the management of wetlands in such a way that benefits current and future generations, that maintains the diversity and richness of wetland ecosystems, and that achieves a balance between material prosperity, social development, spiritual fulfilment and ecological integrity*."

Note that this is not intended as a suggested vision statement: such statements would evolve through the consultative process. Similarly, the principles derived therefrom will depend on the vision itself. Examples derived from the above vision statement, include the following:

- National heritage: wetlands and their biodiversity should be conserved as a national heritage, for the benefit of all.
- Ecological integrity: Wetlands form an integral part of the environment and economy, and their diversity , health and productivity should be maintained, recognising the inter-relationships between wetlands and other ecosystems.
- Economic development: development opportunities should be optimised to meet basic human needs and promote human well-being.
- Social equity: Management efforts should ensure that all people, including future generations, are treated with dignity, fairness and justice.
- Stewardship: Attitudes and perceptions regarding wetlands should be improved in order that people will become responsible for the consequences of their actions, and that they will take responsibility for the wise use of wetlands.

8.6.3 Goals and objectives

Based on this study, we suggest that the following types of goals and objectives be considered for inclusion in wetland policy in the Zambezi Basin countries. However, it is again stressed that the formulation of such goals and objectives would involve a national consultative process, following the guidelines developed by the Ramsar conference parties, and may thus deviate substantially from our suggestions.

Goal: <u>Ensure the conservation of wetland biodiversity and functioning</u>

Objectives:

- Establish core (non-extractive) protected areas within all major wetlands of sufficient size to act as a refuge for wildlife, fish and other wetland biota.
- Rehabilitate degraded wetland areas.
- Ensure sufficient water quality and quantity to maintain ecosystem and human health, through:
  - control of pollution through permit allocations which do not exceed the total absorptive capacity of the wetland

- provision of ecological flow requirements, through restrictions on the impoundment and allocation of water within the wetland catchment area
- control of water weeds, using a combination of government funded mechanisms and incentives for local management

- Ensure a balance between conservation and development through proactive planning involving all stakeholders.

Goal: Achieve optimal and sustainable use practices

Objectives:

- Establish the way in which wetland resources can be optimally and sustainably used
- End existing unsustainable use practices

Goal: Ensure the responsible stewardship of wetland resources by user communities

Objectives:

- Strengthen traditional authority and tenure systems
- Devolve ownership and management responsibility to a local level
- Increase awareness and capacity of wetland functioning, value and wise management practices through education programmes and training.
- Make provision for the use of experienced scientists and managers to provide advice to community leaders and managers

Goal: Promote the recognition and integration of the ecological and economic functions of wetlands in other sector policies

Objectives:

- Recognise the impacts of other sector policies on the use and conservation of wetlands
- Seek to create incentives to encourage wise use of wetlands

9 ECONOMIC PERSPECTIVES ON CURRENT ZBWCRUP WETLAND MANAGEMENT INITIATIVES

9.1 INTRODUCTION

The ZBWCRUP concept arose out of recommendations in a 1995 Canadian International Development Agency (CIDA) report that a three year programme to meet the need for assistance in regard to wetland activities in Zambia, Namibia, Zimbabwe, Malawi and Moçambique be undertaken (Hiscock *et al*. 1996). The Project was also fostered by requests from southern African states for IUCN involvement in environmental considerations in development projects in general, and specifically to consider wetlands (Hiscock *et al*. 1996). CIDA's goal for the project is "the maintenance of the Zambezi River Basin as a viable regional resource for development" (Hiscock *et al*. 1996).

The ZBWCRUP goal is "to conserve the wetlands ecosystems and associated natural resources of the Zambezi River Basin" and the stated main objective is "to develop and promote an integrated ecosystems perspective to the conservation and sustainable utilisation of the Zambezi Basin's wetlands and associated natural resources" (Hiscock *et al*. 1996). This main objective reflects IUCN's mission statement, which is "to influence, encourage and assist societies throughout the world to conserve the integrity and diversity of nature and to ensure that any use of natural resources is equitable and ecologically sustainable". The specific objectives of the project include the promotion of public awareness of the integrated ecosystem approach, the articulation of wetlands value, the improvement of institutional capacity in valuation and EIA, effective communication of those values articulated, and community-based wetlands conservation through wise use strategies. These objectives are in line with IUCN-ROSA's mission "to facilitate and strengthen an integrated approach for the sustainable and equitable use of natural resources and the conservation of biological diversity".

This chapter provides economic perspectives of wetlands management initiatives carried out in the field sub-projects. It is not an assessment of whether activities meet all of the stated ZBWCRUP objectives, but a comment on whether and how the activities can achieve the project goals of conservation and sustainable use from an economics perspective.

For each sub-project region, a summary overview of the current and concluded activities and initiatives is provided. This summary is based upon an analysis of the ZBWCRUP progress reports from 1997 and early 1998, as well as incorporating comments from the Field Project Officers and impressions gained during the reconnaissance field trip. The main activities can be categorised as follows:

- Community well-being,
- Public awareness, information and communication,
- Training,
- Inventory, monitoring and evaluation, and
- Management of wetlands resources.

Wetlands management initiatives cannot be assessed in isolation, but have to be viewed within the socio-economic context within which they are applied. Thus, while the main emphasis is to comment specifically on activities within the last category, many activities in the other categories potentially play a role in determining the success of wetlands management and conservation initiatives and deserve some comment in this context.

9.2 SUMMARIES OF PROJECT ACTIVITIES AND INITIATIVES

9.2.1 The Barotse Floodplain Sub-project

The Field Project Officer set up a sub-project Advisory Committee to give recommendations and advice on socio-political matters.

Three communities were identified as appropriate to be involved in pilot project implementation: Kalabo (Mapunga/ N'unyama), Mongu (Ndau) and Lukulu (Luena Flats). A fourth pilot area was later identified in the Senanga district (Nalolo)

Village wetlands conservation committees were established with representatives from the following structures: existing Barotse Royal Establishment (BRE), institutional structures at grassroots levels, community, government and NGOs. Requests have also been received from community leaders for assistance in the conservation of wildlife, rangeland and fish stocks. The need for training in the setting of targets, inventory of natural resources and management planning was expressed. This request arises directly out of discussions generated in fora such as wetlands conservation committees and workshops. Training workshops in wetlands resource management have been given to local communities. Village natural resource committees have formulated by-laws for management of their resources.

Several workshops/meetings were planned and held in the project areas to initiate wetlands awareness activities. From these and other studies, community consultations and needs appraisals were done. Community well-being issues of provision of water points (health and wells), education and transport (canal clearing, infrastructure, labour and materials) came out as most important. Community participation and cost sharing in these activities was emphasised. A total of 34 km of canals have been cleared in the pilot communities. A further initiative under community well-being, the rehabilitation of a BRE Princess' flood plain residence, was initiated.

A PEEM health study was initiated and a proposal sent to the district health commissioners office. The impact of poor water quality (diarrhoea, eye, skin infections) was listed as critical (as well as being high on the needs appraisal). Several health-related activities were undertaken including community training on shallow well construction in the Ndau area, along with the provision of water testing kits. The extension of Mbanga Rural Health Care Centre was completed. Construction of health posts and training of community health workers are planned.

An educational evaluation of infrastructure and curriculum needs was made and a report is available. Requests for more permanent educational structures were received and the construction of new schools appeared to be the desired direction. The rehabilitation of three schools is underway and the construction of a fourth is planned. A workshop was held to assess community curricula needs for wetlands conservation.

A study was commissioned and carried out to produce a summary of existing socio-economic and ecological data and a report is available.

A contract for the in-depth appraisal of fishing activity throughout the flood plain with emphasis on gender aspects was suggested. A contractor was identified and the study is currently underway. A workshop on sustainable fisheries management of the Barotse Floodplain fishery was held in Senanga. This workshop concluded that the closed season would be observed throughout district (and not just Senanga) for 1998/99 season. Follow-up sensitisation meetings are being held in preparation for the first closed season.

A qualitative assessment of the socio-economic values of wetlands to communities with specific emphasis on gender aspects was conducted, including definition of important resources and indigenous knowledge related to their management.

An energy needs shortfall study was carried out. It included a floodplain-wide assessment of the volume and types of forest products and other energy needs.

The Field Project Officer prepared a dry season campaign (information on fire control) to reduce the prevalence of uncontrolled fire and its ecological and socio-economic impacts. Extension materials have been produced and the campaign is ongoing.

9.2.2 The Chobe-Caprivi Sub-project

The Field Project Officer initiated networking with local authorities, attended a workshop on monitoring and evaluation, a CBNRM workshop by SADC and meetings with the Chobe area District Commissioner, the Caprivi Governor and traditional authorities.

Information dissemination included a weekly Lozi program on wetlands on a local radio station. Posters and calendars on wetlands were produced, advertising the project.

Infrastructural development under the community well-being thrust included the construction of a tribal authority (*kuta*) hall (court) at Kasika, and materials to construct community halls in three other centres.

Three local development committees were also formed, each of which has subcommittees responsible for various activities including natural resource management and income generation.

The PEEM health assessment proposal was studied by the Field Project Officer and a contractual study of health issues in Chobe enclave undertaken. A similar study in the Caprivi is in progress.

A socio-economic and needs-assessment study of floodplain villages has been initiated by the Field Project Officer. A contractual study on food security issues was proposed, but has not been carried out. A photographic 'inventory' of Caprivi was made, and the photographs are being used to communicate project objectives.

An annotated bibliography of current literature on the Botswana side of the study area was commissioned and completed.

A comparison of the ZBWCRUP goals with the goals of other initiatives in the area, e.g. the WWF LIFE Project, was initiated.

The use of fuel-efficient stoves (reduction in wood use) was promoted by the Field Project Officer. These stoves were accepted and utilised by the Kasika community.

The setting up of tree nurseries and agricultural-based projects was initiated by the Field Project Officer. Tree nurseries produce indigenous saplings for reforestation and afforestation. Agricultural projects promote food security through provision of money for seed, irrigation pumps and other equipment. Communities are also assisted with marketing and the selection of appropriate crops. The possibility of cashew nut cultivation is being investigated.

9.2.3 The Lower Shire Sub-project

An annotated bibliography of all existing biophysical and socio-economic literature on the project area was commissioned and completed.

A public awareness and communications programme was initiated which included newspaper articles, a newsletter (articles submitted by students, NGO staff and Govt officials) to students, farmers and NGOs, and a poster. The goal of this initiative was to explain the overall project goal, objectives and expected outcomes to a variety of stakeholders including government, NGOs, local communities and traditional leaders.

An assessment was made of local education needs with respect to infrastructural requirements and wetlands conservation curriculum content. Plans to rehabilitate two schools were made. The communities contribute through the moulding of bricks and the IUCN supplies cement and roofing. Teachers houses and a school were rehabilitated. No report is available as yet on environmental education curriculum needs. Educational use of the Biodiversity team's photo inventory is planned.

As part of the community well-being thrust, two boats optimally designed for river crossing were acquired and handed over to local community authorities.

An assessment of the PEEM health study was done by the Field Project Officer. Drug revolving funds were established in 5 communities in conjunction with the District Health Officer. This scheme helps establish basic health services in villages that are far from the nearest health centre/ hospital (on average 12 km for the 5 communities). The fund supports the training of community-based volunteers in the diagnosis of simple diseases and the dispensing of drugs (e.g. anti-malarial), and community members pay a nominal fee which goes towards drug replenishment. The sub-project provides the initial drugs and the process the becomes the responsibility of the community to maintain. As part of the community health thrust, wells were constructed in 16 communities suffering from poor quality drinking water (and associated health effects e.g. diarrhoea, bilharzia) and a course was held for traditional birth-attendants from 20 communities.

A rapid survey on indigenous knowledge on wetland resources, conservation and utilisation was completed. Ten PRAs in five Traditional Authority areas were planned. Three PRAs were conducted which lead to increased awareness of community needs. Another four PRAs were conducted and community well-being status, needs and opportunities assessed. A survey of gender issues and the role of women in wetlands resources management was undertaken.

A localised fisheries development action plan for Nchacha was commissioned and completed in early 1998. The Field Project Officer sought advice from the Institute for Biological Control on reduction of water hyacinth impacts in the Lower Shire.

A primary thrust of this project is human-wildlife conflict reduction. A pilot project for assessing damage to crops by hippos prior to planting season was planned. Six candidate sites were sought and an agreement with ILLOVO was reached to establish an improved hippo grazing plot adjacent to a hippo herding site to prevent night migration onto community field crops, but the site was never prepared. Discussions were held with communities and authorities on potential avoidance of high human mortality due to crocodiles. Discussions were held with National Parks for comprehensive hippo and crocodile management support for the Lower Shire region. An agreement was reached in principle and a census was undertaken which demonstrated that hippos have decreased and crocodiles have increased since last the census. A draft of a crocodile Management plan for the Lower Shire Sub-project was developed in September 1998. The intention was for the carried out jointly between the Department of National Parks and Wildlife and IUCN, with IUCN's involvement being phased out along with any phasing out of the ZBWCRUP project. Specific activities are: monitoring and analysis of the crocodile population, assessment of human population trends and impacts on crocodiles, reducing crocodile attacks on humans, addressing other human-crocodile interactions, crocodile population management, crocodile habitat management, and community participation.

9.2.4 The Zambezi Delta Sub-project

Contact was sought, initiated and a working relationship was forged with many regional and national institutions on the operational, management and consulting levels. Networking to identify interested and affected parties and communities was conducted.

Schemes to disseminate project results locally included newspaper articles, TV programmes and educational videos. A project brochure was also produced. These initiatives created a greater awareness of wetland sustainable use and conservation issues at all levels. As a pre-requisite for pilot studies, communication with local communities in the delta was initiated. The goal of this whole thrust is ultimately to promote participation of local communities in the sustainable use and conservation of wetlands, policies on sustainable wetlands management and provincial and national planning documents that include wetlands issues.

A team of local expertise was trained in socio-economic, biophysical and communication data gathering techniques. This team formed the core of the experts to conduct the village surveys mentioned below

An inventory study of Delta resources was commissioned. A forest inventory was contracted and completed. A wetlands inventory was contracted and begun. A study of the delta fisheries was contracted and completed. These studies were carried out by DNFFB for the IUCN, and include an assessment of the capacity for increased harvesting and lead to an increased understanding of Delta resources and sustainable harvesting levels. These studies are collated in "*Avaliacao dos recursos florestais, faunisticos e pesqueiros no delta do Zambeze*". Finally, physical data on the delta was collected and collated by the *Instituto para o Planeamento Fisico* (INPF).

The project has generated advice on the management actions required to minimise the impact of development schemes and specific advice has been provided on development projects such as the renewal of the Sena Sugar concession. The goal for the project is to ultimately incorporate wetlands issues into regional development plans.

Several pilot study areas were identified and contractually selected. Pilot projects to assess community use of wetlands were begun with full community participation. The trained resource assessment teams went into the pilot villages, collected baseline data, drew up reports on each pilot site. These pilot studies give a picture of local communities' relationship with wetlands ecosystems. Their socio-economic needs, and the biophysical, institutional, economic, social and political factors affecting household and community use of natural resources are identified. Appropriate land tenure regimes were identified by NET (*Núcleo do Estudo de Terra,* UEM) and secured by being gazetted by government. Based upon the surveys and other community needs assessments, potential options for community-based wetland resource initiatives were identified. The pilot initiatives for the management of resources, which include community involvement in the management of *Coutada* 14, support to palm wine production and marketing, community-operated hunting concession in Zambézia Province and fisheries support at Chinde, are not yet in place, and are pending negotiations between the community and the private sector. Potential options for immediate community based wetland resource initiatives were identified as:

- pottery and brick works projects (a pilot initiative is underway and already productive); and
- Borassus palm tree wood utilisation (a pilot project involving wood sawn experimentally for construction material was conducted and a pilot joint investment project between communities, the private sector and the IUCN is currently being negotiated with DNFFB).

In addition, a project has been initiated in the Delta to assist communities in the Chinde area to restore depleted mangrove stands.

9.3 ECONOMIC PERSPECTIVES

The main emphasis of the FPO activities has been on addressing the well-being of communities in the study areas through needs assessments and follow-up activities. These include the provision and improvement of infrastructure such as halls, schools and palaces, dredging of canals, the provision of wells and boreholes for improved access to water, implementation of community health funding schemes and health training, and activities to enhance agricultural productivity and food security.

In theory, community wellbeing has an important influence on the way in which people manage and exploit natural resources. It is widely upheld that community development reduces the need to overexploit natural resources and that it is a prerequisite for sustainability. Indeed, poor communities have more of a need to overexploit natural communities than wealthier ones, but an improvement in well-being, or increased wealth, does not necessarily remove the incentive to overexploit resources. In fact, welfare improvements sometime increase the pressure on resources, through the attraction of more people to the advantaged communities, especially in situations where natural resource property rights are poorly defined. Thus, whilst community development projects such as these are essential if conservation initiative are to be successful, they do not by themselves change peoples behaviour towards the more sustainable use of resources. These behavioural changes are better brought about by initiatives such as those described below.

In addition, community well-being projects such as these are important for building trust and co-operation of the communities with conservation organisations such as the IUCN. However it is important to ensure that the community retains the awareness of the primary goal of the organisation, as being conservation-oriented, so that the linkages between development, welfare improvement and wetlands conservation are always made.

In all the study sites, the FPOs have been extensively engaged in communication and activities to enhance public awareness of the project and of the value of wetlands conservation and management. These activities have taken the form of media presentations, workshops and networking with stakeholders, and the development of school curricula on wetlands conservation and management. These initiatives, such as the formation of school conservation clubs, are essential to the project goals. The value of education cannot be overemphasised. Education and awareness lead to increased value perceptions and greater receptiveness to policy initiatives and regulatory mechanisms. Nevertheless even communities that are fully aware of wetlands conservation issues may be powerless to effect changes in patterns of use, especially if they are extremely poor or if they lack the necessary management skills. Thus welfare improvement and awareness and education need to go hand-in-hand in order to maximise the chances of success, and training and co-operation between local communities and appropriate institutions are necessary follow-ups.

There has been a wide range of training in the project areas, following approximately 50 training sessons involving 65 men, 60 women. In addition, approximately 50 children have been trained through conservation clubs. Areas of training have included fisheries, agriculture, soil and water conservation, marketing, pottery, embroidery, cooking, typing, mangrove planting, growth monitoring, economic valuation, primary health care, environmental heatlh, operation of drug revolving funds, stores management, mechanics and computer skills. This training has taken place within the relatively short timescale of the project, however, and needs to be reinforced with follow-up training in future.

Literature reviews and resource inventories have been carried out in all four study areas in order to provide baseline information on natural resources and socio-economic data. Accurate socio-economic data facilitates appropriate goal setting in development projects and resource management. These data are also a prerequisite for the determination of economic values, and hence facilitating development decisions that involve trade-offs. It is well known that imperfect information leads to distortions in economic policy- and decision-making. Detailed information on natural resource use and availability is also fundamental to the understanding of household survival strategies, without which it is impossible to address resource management effectively. While significant amounts of useful information have been gathered in some of the project areas, there will be a need for more in-depth studies of the more important natural resources in order to determine optimal economic levels of use and management strategies. The setting up of natural resource and socio-economic monitoring programs would be extremely valuable for sustainable development in the long term.

A number of activities have been initiated on the management of natural resources in the different study areas. These include projects to reduce pressure on fuelwood resources, to reduce human-wildlife conflicts, to increase income from natural resources, and the establishment of local management committees and revised land tenure systems.

While improved well being can lead to reduced demand for certain natural resources, this demand can in some instances better be addressed through improved technology. Thus the promotion of the use of improved woodburning stoves decreases the need for fuelwood without imposing excessive cultural change or new resource needs (e.g. gas) on the community. Such initiatives help to improve the efficiency of natural resource use, allowing more sustainable use and hence imparting a greater net present value on the resource.

The mangrove restoration project in the Delta is relevant to areas immediately around the town, where there is some evidence of depletion. Here, IUCN has been providing financial and technical assistance in the propagation of and re-establishment of mangrove species in the areas concerned. Data presented in section 4.5.6.1, and 4.6.8, above, shows the importance in economic and financial terms, of use of the mangrove resources in the study area. This is significant. However, residents of Tanque, only nine kilometres from Chinde, indicated in focus groups that they found mangroves still plentiful, although they were declining.

The commercial value of the mangrove restoration project will depend on whether the cost of having to harvest mangrove products from further afield, due to depletion, is more than the cost of reforestation of the depleted areas. We have no figures for this, but it seems unlikely, given the feelings of the Tanque residents, and the fact that large areas of mangroves, which are not depleted, are present just across the river from Chinde. The economic value of the project, however, may be different, since non-use, and indirect use, values could be relevant. The financial investment of IUCN in the project is unlikely to be recovered in terms of returns of direct use value. However, if this investment is seen as being largely a manifestation, or realisation, of non-use values (the donor's willingness to pay for mangrove conservation) then the project could be economically efficient. We suggest that it is in this context that the economic viability, and thus any future investment in the project should be assessed.

Human-wildlife conflicts, particularly involving crocodiles and hippopotami, were identified in all four of the study areas, but were the most severe in Lower Shire. The economic losses, including loss of life as well as loss of agricultural and fishery outputs, imposed on wetland communities by these animals provides a large incentive to the afflicted communities to eradicate them, conflicting with conservation goals. Management actions to date may have helped to prevent their extirpation from these areas, but apparently have not had much of an effect in mitigating the costs to the local communities.

From an economic perspective, a primary thrust of the crocodile management plan is to advocate and support the sustainable harvest of crocodiles with a component of the profits accruing to local communities. The Nile crocodile is listed on Appendix II of the Convention for International Trade in Endangered Species of Fauna and Flora (CITES), and under this convention Malawi has a harvest quota and trade of some 200. The Department makes use of licensed hunters to kill crocodiles as part of problem animal control, and although only a third of licensed hunters are in the study area, a relatively large number appear to be killed there (for example, 162 in December 1997). Communities have enjoyed no benefits from the culling activities, with the licensed hunters deriving all the benefit from sale of the skins. Under the plan, an increase in the CITES quota would be requested. A rigorous survey of the crocodile population would have to be made before such an increase could be approved. Rational management and utilisation of the crocodile resource would be instituted.

The basic approach to control of crocodile numbers would be direct culling of wild adult and perhaps juvenile crocodiles and sale of the skins. Of all options for the utilisation of crocodile, this type of activity involves only small amounts of capital, relatively simple technology, and reasonably high profits. However, removal of only several hundred animals per year would result in turnover, which is relatively insignificant. For example, we estimate that removal of 250 animals per year would result in a turnover of less than MK 2.5 million, or US$56,000. After subtraction of hunting costs and a share of profits for the hunter, the annual amount available for communities would likely be less than 20 percent of this. Given the very high levels of intolerance to crocodile among the more than 300,000 people in the study area, and the relatively small potential income, it is highly questionable whether, for communities, the benefits from culling will completely offset the costs of tolerating crocodiles in the area.

An alternative use of wild crocodile populations, as practiced in Zimbabwe and Botswana, involves harvesting of eggs from nests, and use of these eggs in intensive hatching and rearing facilities for slaughter (crocodile ranching). This type of activity capitalises on the very high reproductive potential of crocodile and results in the production of very large numbers of skins, and other products. If it is economically profitable, significant value added can be generated. However, it is highly capital intensive, requires very high levels of technical and managerial skills, needs to be of large-scale (more than 5,000 skins) for viability, has moderate profitability, and requires large quantities of relatively high quality feed in the form of meat or fish. The latter requirement generally makes large-scale crocodile ranching unsuitable for underdeveloped countries, where such feed resources have high opportunity cost. In the last decade the world price of crocodile skins has been depressed due to oversupply, most of which comes from farming and ranching activities. High price-inelasticity of supply suggests that any cyclical price change is likely to be slow. It is possible that the population of crocodiles in the study area could provide eggs to support one or more crocodile ranching operations. However, due to the feed constraint, and current profitability problems, such an activity would not likely be viable at present. In any case, because of the high skill requirements of ranching, community benefits would likely be mostly restricted to those from the sale of eggs.

It is concluded that the commercial value of crocodile management in the Lower Shire will be low. The return, in terms of direct use values, on the investment in census and other inputs will most likely be low. However, in economic terms, crocodile management embraces a broader set of values. Non-use values associated with crocodile and the degree to which these could be realised by communities are unknown. Currently the situation is inefficient, in that high costs associated with the resource are borne by communities who do not receive any of the benefits associated with the resource. By allowing benefits and some control to flow to communities, the plan promises to make the situation more economically efficient. It will also create mechanisms where communities could possibly capture crocodile non-use values in the future. The implementation of crocodile management can be expected to have a positive economic impact.

Some of the project activities aim to realise untapped potential value of natural resources, although these initiatives are understandably restricted to the Delta area, where many resources are relatively abundant and under-exploited. Initiatives such as this will most likely enhance the economic well-being of communities, provided the rules governing resource use are founded in sound knowledge of both supply side (the biological and ecological aspects of the resources), as well as demand side (marketability and value) of the resource. The opportunity costs of utilising new resources (e.g. compromising tourism value) should also be taken into consideration.

The sustainability of economic values derived from natural resources is ultimately dependent on property rights and the conditions governing their management. In all of the project areas the communal ownership of resources predisposes them to the potential for overexploitation should social norms or traditional systems of regulation slacken or break down. Whereas communal ownership of resources *per se* does not necessarily lead to open access conditions, it is imperative that the property rights of resources are well established, whether by traditional means or through government regulation or private tenure. In the delta, where traditional systems of management have been altered by political changes, action has been taken for communities to acquire secure land tenure. Whereas poorly-defined user rights are usually associated with the risk of overexploitation of existing resources by local communities and private sector investors, secure land tenure will encourage investment in, and sustainable use of, natural resources, as it provides long term security to returns on investment. Communities will have greater incentive to manage their resources optimally, and will also have greater opportunity to benefit from private sector investment. Nevertheless, it is important that secure land tenure is backed up by sound management advice. In certain cases, it may require government regulation.

Initiatives to encourage private sector investment are potentially highly valuable to local communities. In many cases the exploitation of new resources is prevented by the capital investment (often even small) that is required to initiate enterprises. Thus private sector investment can effectively "unleash" flows of values that were previously unattainable. However, it is again imperative that property rights are well defined in order to ensure that the distribution of these benefits is equitable.

In Barotseland, where traditional management and tenure systems are still relatively strong, but nevertheless increasingly vulnerable to breaking down, committees have been formed in pilot project areas to assess their ability to improve natural resource management. The fact that these committees have already taken considerable steps in reinforcing traditional management systems through regulatory bylaws, illustrates how well communities can respond to heightened awareness and empowerment, given the incentive of increased and more sustainable values to be potentially obtained from the wetland. The fact that the committees that have taken the major decisions (e.g. closed fishing seasons), are made up of members of the community, will lead to much greater compliance and self-enforcement of the new by-laws than if the laws were imposed by outside bodies.

9.4 CONCLUSIONS

To fulfil the primary goal stated in the introduction, more emphasis needs to be placed on those activities that attempt to understand household or community behaviour and influence behaviour patterns that directly affect wetlands conservation and degradation. The greatest impact can be made where real, and perceived, value to local communities and associated changes in value through use and degradation is understood by both researchers and the communities themselves. Such understanding will be vital in influencing behaviour at the local level through economic incentives and at the national level through regulatory and policy interventions.

Most of the wetlands management initiatives discussed above are still in intermediate stages of implementation, and to attempt a quantitative analysis of the economic effects and implications of most of these activities and initiatives is beyond the scope of this study. Although it is possible to make informed comments, as in this chapter, about how these initiatives enhance the value obtained from wetland resources, it is recommended that economic consequences of these initiatives are monitored and analysed.

Now that the basis has been laid in the field, and in view of the above findings, it is recommended that further field activities be more co-ordinated and focussed directly at the following elements, in the following order of priority:

1. facilitating the attainment of appropriate *common property regimes* among communities, and relevant institutions, e.g. conservancies in Chobe-Caprivi wetlands;
2. the *alleviation of human-induced pressure on resources*, through both innovation (e.g., more efficient harvesting techniques) and development of unused resources;
3. improving *awareness and education*
4. assistance for the communities in *management planning and developing systems for this*, for both conflict reduction, e.g. wildlife human conflicts, and for increasing economic efficiency in terms of securing both human livelihoods and national welfare, while simultaneously avoiding loss of biodiversity and non-use values;
5. provision of and assistance *training,* e.g. in enterprise management.

10 CONCLUSIONS AND RECOMMENDATIONS

Wetlands are a dominant feature within the Zambezi River basin and are home to several million people whose livelihoods depend on the state of the resources within them. Wetland resources in all four wetlands are still traditionally used as a source of building materials, craft material, and for hunting and fishing, and wetland margins are used for grazing cattle, growing crops and access to water. This study demonstrates the high direct consumptive use value of the wetlands. The potential non-consumptive use value of the wetlands has, however, barely been tapped. The wetlands also have considerable indirect use value not only to local communities, but to communities beyond their bounds. Their hydrological functioning ensures the productivity of agriculture and the recharge of groundwater, and their vegetated habitats provide flood control, trap of sediments, purify water and act as breeding areas for many species of economic importance. These values, although difficult to quantify in monetary terms, are pervasive, but are seldom fully appreciated by the sectors that benefit from them.

Despite their large economic value, these wetlands are under threat from numerous economically-driven processes. An analysis of the *status quo* situation shows that the values obtained from the wetlands are likely to be compromised in future, particularly at the household level, due to lack of sustainable management. Broader-scale processes such as agricultural and upstream hydrological developments further threaten the ecological integrity and economic value of the wetlands. With the former, the economic benefits may not outweigh the costs in terms of wetland losses, but with the latter, the economic benefits of providing water and power probably greatly outweigh their external costs. However, the cost of compromise in the design of such schemes to maintain ecological functioning would almost certainly be worth it in terms of the savings in wetlands values.

The optimal management of wetlands is likely to include a mix of options in order to maximise benefits to local communities, countries and the region. Without a doubt, this includes the wise use or sustainable management of resources that are directly used within the wetlands, and the maintenance of ecological functioning through regulation of upstream activities. Agricultural development brings local benefits but would need to be justified at a national level, and an optimal scenario is unlikely to include more than a fraction of wetland area for this purpose. In all cases, wetlands would benefit from some degree of formal protection. While this displaces certain local activities, such as resource harvesting, grazing, and cultivation, it brings benefits in terms of the recovery of source stocks to the remaining areas, as well as potential benefits from tourism investment. The optimal size of protected area depends on the level of protection, and with a relatively large limited-use type of protected area, the core "hands-off" protected area need only be relatively small.

With a lack of specific wetlands policies in the Zambezi Basin countries, wetlands activities are affected by policies from a number of sectors. Often inadvertently, many policies which work well in other parts of the countries are detrimental to wetlands. Overall analysis of policies reveals that there are more policies which encourage wetland degradation than conservation. The main conclusion in this regard is that there is an urgent need for the development of comprehensive wetlands policies. Such policies should aim to:

- ensure the sustainable utilization of resources so as not to compromise the needs of future generations;
- limit practices which reduce wetland productivity;
- maintain biodiversity;
- maintain wetland functions and values;

- encourage the research required to determine sustainable limits in terms of all of the above
- integrate wetland concerns into the planning and decisions making of other sectors; and
- precipitate the comprehensive spatial planning of wetlands uses.

Achieving these aims will mean tackling policy and, particularly, action at local, national, regional levels. Since wetlands are a multi-sectoral resource, there is the need to create and establish an appropriate institutional arrangement for their management. The following are seen as necessary prerequisites for maximising wetland benefits.

The major rivers of the Zambezi basin are transboundary resources, and need to be managed as such. Hydrological developments in one country affect ecosystems in the next. All development of these resources should be subject to **international** negotiation which should take these effects into account.

At a **national level**, governments and other agencies should aim to:
1. raise *awareness* of the ecological and economic value of wetlands, and how these are threatened and *raise existence values;*
2. *foster an environmental ethic* through education;
3. maintain acceptable *hydrological regimes*, including flooding, in all aquatic systems;
4. implement *water demand management;*
5. implement *environmental water supply management,* such as erosion control in catchments;
6. incorporate resource economics analysis as a mandatory part of all environmental impact assessments and cost-benefit analysis;
7. implement *strict standards and regulation* on the damaging outputs of urban and industrial development and agriculture and forestry;
8. introduce *economic incentives for self-regulation* in these sectors, such as tradable pollution permits;
9. increase *cross-sectoral institutional co-operation;*
10. address *population issues* through economic and social policy with the aim to decreasing the dependency ratio in rural areas;
11. implement effective *AIDS prevention* strategies; and
12. *empower* local communities, through *traditional authority*, to manage resources in partnership with or under the advisement of national conservation agencies.

At the **local (wetland) level,** governments and other agencies should aim to:
1. ensure *spatial-temporal planning* of wetland uses to avoid piecemeal encroachment on wetlands by agricultural and other development;
2. subject future planned developments to comprehensive environmental and economic impact assessment, viewed within the planning framework;
3. avoid any drainage of wetland areas
4. seek to incorporate formal protected areas within wetlands, in such a way as to maximise their potential economic benefits;
5. encourage private investment and community participation in tourism ventures, for example, through partnerships with government conservation agencies and through the establishment of conservancies;
6. promote *inventories* of wetland resources and *research* on sustainable yields and other conservation measures;
7. *monitor* the status and use of natural resources
8. use *traditional knowledge* to aid in planning;
9. improve *awareness and education* pertaining to local wetland issues;

10. *discourage illegal hunting* by realising benefits to communities from problem animals and other animals which are integral to wetlands functioning and tourism, for example by pay-offs in cash or in kind to communities by conservation organisations in proportion to annual censuses of these animals;
11. facilitate the attainment of appropriate *common property regimes* among communities, and relevant institutions for the management of natural resources;
12. encourage the *inclusion of women* in resource management;
13. facilitate *communication or co-management* between local resource managers and government or NGO expertise;
14. encourage district authorities to make *local by-laws* to enforce appropriate sustainable use practices, such as regulation of burning, total protection of marshes from burning, and regulation of harvesting methods and effort;
15. take action to *alleviate human-induced pressure on resources*, through both innovation (e.g., more efficient harvesting or cooking techniques) and development of unused resources;
16. *involve local communities* in any commercial enterprises which utilise wetland resources;
17. promote government and NGO assistance to communities in *management planning and developing systems for this*, for both conflict reduction and for increasing economic efficiency;
18. provide *training* (e.g. in enterprise management); and
19. take cognisance of existing traditional users and make all attempts to accommodate them within new uses such as protected areas.
20. employ broad economic criteria when making decisions on whether to invest in field interventions in the study areas.

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APPENDIX 1A

REGIONAL CAPACITY IN RESOURCE ECONOMICS AND WETLANDS VALUATION

INTRODUCTION

Most African countries are signatories to the Convention for Biodiversity Conservation, and as such, have an international obligation to promote both sustainable development and conservation of their natural environments. Since developing countries depend heavily on their natural resource base for continued development, the central issue concerning many governments is the creation of conditions for the sustainable use of such resources. However, it is difficult politically for governments to justify the institutionalised protection of natural resources during the early stages of economic growth. Sustainability thus needs to be understood not only in ecological, but also in economic, social and political and institutional terms if policy and management actions are to provide the optimal path for sustainable development.

It is under these conditions that the relatively new and rapidly developing field of environmental and resource economics has become increasingly applied and promoted in decision-making in the region. However, there is a vast capacity gap in regional resource economics which often results in resource decisions being taken under conditions where they might have been better informed. There is also often a lack of communication and understanding between contracted experts and agency personnel on what is required and what is actually demonstrated by the results of studies. Typically to date, resource economists contracted in the region tend to be contracted from outside of the region. The lack of regional capacity has been recognised by many institutions and several initiatives are underway to promote capacity building in this field.

In this chapter, we identify regional expertise and institutions with an interest in the valuation of wetland goods and services, as well as appropriate institutions in which to build capacity. We present a framework for the enhancement of institutional capacity through training in resource economics. Finally, we identify several specific project requirements for capacity building in wetlands valuation techniques. Much of the information in this section was volunteered during discussion with several of the people listed in the following section.

IDENTIFICATION OF CURRENT REGIONAL EXPERTISE AND INSTITUTIONS WITH AN INTEREST IN WETLAND VALUATION

To identify regional expertise, we prepared a survey (Box 1) which was sent by email and fax to all regional expertise in resource economics and/or wetlands resource use known to the consultants, as well as to the Environmental Economics Network of Eastern and Southern Africa (EENESA), the AFRECO-NET electronic discussion list and the International Environmental and Resource Economics electronic discussion list RES-ECON. An estimated total of 900 people were surveyed globally and we received a return of 77 questionnaires from experts who have some African experience in resource economics and/or wetland issues. These form the core of the regional resource economics Expertise Database (Box 1). The database contains names, contact details, background information on people working or interested in the field, details of experience in economic valuation, geographical areas of experience, and their fields of interest. Most information is from survey responses, but names of others known to be working with resource economics issues in the region, were also included in the database. It must be noted, however, that this list is probably not exhaustive, and that important workers and institutions in the field may have been excluded from our list. The database is also available as an Microsoft Excel 5.0 Read-Only file on the accompanying disk.

Review of expertise

A total of 70 persons based in 18 different countries responded to the survey, as having appropriate expertise, and several additional people from eastern and southern Africa involved in the field of resource economics were also identified (Table 1). Respondents indicated either experience in wetland valuation and/or general economic valuation, as well as any other practical experience in wetland ecosystems. Those that responded in the negative to both of these questions but indicated some other resource economics experience and an interest in wetland resource economics are also listed.

Regional experience in wetland valuation is limited (Table 1), and some wetland valuation experts have worked on only a few projects. Wetland valuation experience is limited to 15 countries (South Africa, Namibia, Botswana, Zambia, Malawi, Moçambique, Zimbabwe, Democratic Rep. Congo, Kenya, Nigeria, Chad, Cameroon, Niger, Madagascar and Sierra Leone) with few countries having had more than one study conducted in them. Four of the experts have gained much of their experience through valuation of wetlands in the 5 countries covered by this project.

From a country perspective, it is notable that 41% of respondents that have worked in the region originate from outside Africa. A further 28% of respondents are based in South Africa. These figures highlight the severe dearth of resource economics capacity in Africa. Trends evident in the Expertise Database serve to confirm this.

Box 1. SURVEY OF EXPERTISE IN NATURAL RESOURCE ECONOMICS AND WETLAND VALUATION IN CENTRAL-SOUTHERN AFRICA

On behalf of the IUCN-ROSA, we are compiling a list of expertise in environmental and resource economics in central-southern Africa, with particular emphasis on wetland-related expertise. This survey is being posted to the members of EENESA, Afreco-Net and Res-Econ as well as faxed to additional names that we have listed as being at least peripherally involved in the field. If you have experience in central-southern Africa, it would be appreciated if you could complete the short questionnaire below and help us to identify additional people that have interests in this area of study. If you are aware of any such expertise among colleagues or members of other institutions, we would appreciate it if you could copy this survey to them.

[Where applicable, tick the options that apply]

1. Involvement in environmental and resource economics
   _____Casual interest _____In training
   _____Academic _____Professional

2. Background
   _____Biological sciences _____Environmental sciences
   _____Social sciences _____Other_________________

3. Training in environmental and resource economics
   _____Largely self-taught _____Short courses/ undergraduate courses
   _____MSc degree _____PhD degree

4. Number of years experience (since commencing training) _______

5. Main field(s) of interest in environmental and resource economics

_____Urban and environmental issues (e.g. pollution)
_____Policy
_____Water
_____Agriculture & land-use
_____Utilization of natural resources (including fisheries)
_____Conservation
_____Tourism
_____Valuation of natural resources
_____National accounting
_____Project appraisal and impact assessment

6. Do you have practical experience in the application of valuation methodology?
   _____No (or very little) _____Yes _____Yes, including wetland studies

7. Do you have any other practical experience involving wetlands?
   _____No/Yes

8. Geographical area of experience
   Please list the main countries or geographic regions where you have worked or studied in this field. Please indicate with an asterisk* in which of these, if any, you have worked on wetlands.

9. Please supply the name of your institution and your contact details

10. Other contacts
   Our list is not comprehensive. Please could you supply the names and contact details of anyone else that you know working in the field of environmental and resource economics in central-southern Africa.

PLEASE FAX YOUR RESPONSE TO: DR JANE TURPIE +2721 650 3295
(or email a response to <jturpie@botzoo.uct.ac.za>)

Table 1. Expertise in resource economics in eastern and southern Africa, with particular reference to wetland valuation, economic valuation, practical experience in other wetland issues (e.g. ecology) and people with an expressed interest in resource economics pertaining to wetlands (full details in Appendix 2).

Name	Country Of Residence	Valuation Experience in Africa	Experience with wetlands ecology etc	Interest Only
Barnes, Dr Jonathan	Namibia	✔ (incl. wetlands)	✔	
Cavendish, Dr Will	UK	✔ (incl. wetlands)	✔	
Hatch, Prof. Upton	USA	✔ (incl. wetlands)	✔	
Howe, Prof. Charles W.	USA	✔ (incl. wetlands)	✔	
Meyer, Kerry K.	USA	✔ (incl. wetlands)	✔	
Neiland, Arthur	UK	✔ (incl. wetlands)	✔	
Scott, Guy	Zambia	✔ (incl. wetlands)	✔	
Turpie, Dr Jane	South Africa	✔ (incl. wetlands)	✔	
Wilson, Prof. James R.	Canada	✔ (incl. wetlands)	✔	
Emerton, Lucy	Kenya	✔ (incl. wetlands)		
Guveya, Emmanuel	Zimbabwe	✔ (incl. wetlands)		
Smith, Brad	South Africa	✔ (incl. wetlands)		
de Boer, Dr W. F. (Fred)	Moçambique	✔	✔	
Idassi, Dr Joshua	USA	✔	✔	
Kerley, Dr Graham	South Africa	✔	✔	
Knickel, Dr. Karlheinz	Germany	✔	✔	
Kramer, Prof. Randall	USA	✔	✔	
Laxminarayan, Dr R.	USA	✔	✔	
Mahendrarajah, Dr. S.	Australia	✔	✔	
Mander, Myles	South Africa	✔	✔	
Orr, Dr Blair	USA	✔	✔	
Pendelton, Prof. Linwood	USA	✔	✔	
Samways, Prof. Michael	South Africa	✔	✔	
Wesseler, Dr Justus	USA	✔	✔	
Ashley, Caroline	UK	✔		
Ballance, Anna	South Africa	✔		
Bartel, Paul	USA	✔		
Bate, Roger	UK	✔		
Blackie, Rob	Namibia	✔		
Blignaut, Dr J.N.	South Africa	✔		
Chaweza, R.	Malawi	✔		
Chitara, Sergio	Moçambique	✔		
Conradie, Beatrice	USA	✔		
Els, Dr. Herman	South Africa	✔		
Geach, Bev	South Africa	✔		
Goldblatt, Michael	UK	✔		
Harpman, Dr David	USA	✔		
Krug, Wolf	UK	✔		
Meister, Prof. Anton D.	New Zealand	✔		
Milne, Dr Grant	Zimbabwe	✔		
Perlmann, Candice, S.	South Africa	✔		
Shackleton, Dr Charlie	South Africa	✔		
Sumaila, Dr. U. R.	Canada	✔		
Joubert, Alison	South Africa		✔	

Name	Country Of Residence	Valuation Experience in Africa	Experience with wetlands ecology etc	Interest Only
Bemigisha, Jane	Uganda		✔	
't Sas-Rolfes, Michael	South Africa		✔	
Antona, Martine	France		✔	
Cohen, Dr Mike	South Africa		✔	
Ellsworth, Dr Lynn	USA		✔	
Harland, Charlotte	Zambia		✔	
Southwood, Alan	South Africa		✔	
Arntzen, Dr Jaap	Botswana			✔
Berns, Jutta	South Africa			✔
Bond, Ivan	Zimbabwe			✔
Chaweza, Regson	Malawi			✔
Child, Dr Brian	Zambia			✔
Chitiga Mabugu, Dr Margaret	Zimbabwe			✔
Creemers, Geert	South Africa			✔
Damte, Fasike	Ethiopia			✔
De Wit, Martin	South Africa			✔
Dore, Dale	Zimbabwe			✔
Fernhead, Peter	South Africa			✔
Fidzani, Dr N.H.	Botswana			✔
Gaobotse, Ditshupo	Botswana			✔
Hartley, Richard	Botswana			✔
Hassan, Prof Rashid M.	South Africa			✔
Humavindu, Michael	Namibia			✔
Jama, Dr Mohamud	Kenya			✔
Kalinda, Beatrice	Zambia			✔
Kamphasa, Bernard	Zambia			✔
Kelly, Dr. Terry C.	New Zealand			✔
Kereke, Munyaradzi	Zimbabwe			✔
Koaatsa, Nthabiseng	Lesotho			✔
Korrubel, Jan	South Africa			✔
Leiman, Anthony	South Africa			✔
Le Maitre, David	South Africa			✔
Lumby, Prof. A.B.	South Africa			✔
Mabugu, Dr Ramos Emmanuel	Zimbabwe			✔
Masirembu, Simon	Namibia			✔
Mkenda, Adolf	Tanzania			✔
Morris, Belinda	UK			✔
Motinga, Daniel (John)	Namibia			✔
Mungatana, Eric	Kenya			✔
Muriira Ikiara, Moses	Kenya			✔
Naguran, Ray	South Africa			✔
Ngulube, Gibson	Zambia			✔
Ngwenyama, David	Zambia			✔
Nyangena, Wilfred	Kenya			✔
San Martin, Orlando	Norway			✔
Sikoyo, George	Uganda			✔
Simelane, Dr Vakashile	Swaziland			✔

Name	Country Of Residence	Valuation Experience in Africa	Experience with wetlands ecology etc	Interest Only
Tlhalefang, Jonah	Botswana			✔
Traill Thomson, Dr Jo	Swaziland			✔
Tren, Richard	South Africa			✔
Tsheko, Botswiri	Botswana			✔
Van Nieuwenhuizen, Diekie	South Africa			✔
Van Zyl, Hugo	South Africa			✔
Wanjiku Kabubo, Jane	Kenya			✔

An analysis of the main database (Appendix 1b) yields several interesting trends. A median of 7 years experience in resource economics among experts indicates both the relative youth of the field as well as the emergence of new capacity in response to current trends and initiatives; 45% of experts are still in training or have less than 5 years experience since commencing training. Less than 50% of resource economics expertise in the region is formally trained as such. In fact, 56% of expertise originates from the biological, environmental and agricultural sciences, and other resource management backgrounds. The remaining expertise has a background in formal economics, environmental and resource economics, agricultural economics and sociology, with more than 50% of these experts originating outside of Africa.

While many experts responded as being trained with PhD's or Masters degrees, the question expressly requested training in environmental and resource economics. Since we are aware that many of the respondents who claimed PhD's and Masters degrees have in fact only completed short courses or are largely self-taught in resource economics, we believe that the question was misinterpreted in too many instances to be useful to analyse. It is interesting, however, to note that almost 40% of respondents indicated that they are self-taught or have attended short courses in resource economics, the majority of these occurring among experts whose backgrounds are primarily in the biological and environmental sciences or other non-economic fields. This indicates both the trans-disciplinary nature of resource economics work and the lack of formally developed capacity in the region which has probably necessitated these experts with non-economic backgrounds adapting to new skills as required.

Some 59% of expertise is both academic and professional in nature. This seems to indicate that much contract work is channelled through academic institutions, but a closer analysis reveals that many respondents who claimed to have an academic career are in fact working for NGOs or government ministries, indicating perhaps that this questions was also misinterpreted to some degree. The remaining expertise is almost all professional in nature.

Review of current institutional capacity and capacity building initiatives

The following section identifies the current institutional capacity in resource economics in the ZBWCRUP countries of Namibia, Botswana, Zambia, Zimbabwe, Malawi and Moçambique, and other neighbouring African countries. All the major academic institutions in the region have relatively good to excellent Departments of Economics.

ZBWCRUP countries:

The University of Zimbabwe offers additional degrees in agricultural economics which optionally included resource economics. There are also ties with the Centre for Applied Social Sciences (CASS) and opportunities in multidisciplinary postgraduate degrees.

The University of Botswana has a programme on "Environmental economics and sustainable development" co-ordinated by the Department of Environmental Science with inputs from the Department of Economics and the National Institute for Research. Courses are offered in Economics and Mineral resources and Economic aspects of NRM during the final undergraduate year. At the postgraduate level, courses are offered in NRM and Environmental Economics. Supervised Masters and PhD dissertations in Environmental Economics are offered to economics and environmental sciences students. In addition, UB offers short courses with Environmental Economic inputs (EIA and pollution control, Economics and NRM) annually in June.

Currently, there is no formal university training in environmental and resource economics in Namibia. The Department of Economics, Faculty of Economic and Management Sciences, at the University of Namibia is changing its three year bachelors degree to a four year one, and will be adding an optional module in environmental economics as part of the fourth year economics course as well as offering a module in agricultural economics.

Both the Universities of Zambia and Malawi have some resource economics capacity through trained academics. While there may be scope for the supervision of postgraduate students, critical mass is lacking for coursework training.

The University Eduardo Mondlane, Moçambique, has an Economics Department as well as several experts working on resource economics issues, but there is little training capacity other than potential for possible postgraduate supervision.

Other countries:

Through its high number of relatively well-funded universities, South Africa has the greatest regional academic capacity in the field, explaining in part the dominance of regional expertise from this country.

The University of Cape Town has several trained resource economists. The School of Economics offers a module in environmental economics at Honours level and a Masters degree in the subject by coursework and short dissertation. Masters students in Conservation Biology receive an intensive module in resource economics. Some resource economics components are also taught to Environmental and Geographical Science Masters students and Engineering students.

The University of Pretoria's Department of Agricultural Economics has a specialist chair in resource economics and as part of their postgraduate programme they offer an option of specialisation in environmental economics and policy (MSc and PhD students). They also teach, as part of the Honours/ Masters programmes, two courses in environmental economics. Both are semester courses. The first course is a general introduction and the second is a more advanced course with large emphasis on quantitative methods and modelling. There is ongoing postgraduate supervision here.

The Institute for Natural Resources (INR), University of Natal, Pietermaritzburg has some resource economics capacity among its researchers and there is the potential for supervision for masters students on issues of resource use and some resource economics. The University of Natal, Durban has a Department of Economics & Management which offers some resource economics modular coursework and may take on postgraduate students. They offer a variety of multidisciplinary environmental management postgraduate degrees including Agricultural Economics. The University of the Witwatersrand offers a week-long module in resource economics to its Conservation Biology Students annually. The University of Stellenbosch offers courses in Agricultural Management and Agricultural Economics

Makerere University, in collaboration with the Uganda Centre for Sustainable Development and the British Council has been running a number of short courses (2 weeks) annually for policy-makers and planners from the East Africa region (Kenya, Tanzania, Uganda, and Ethiopia) on Valuing Natural Resources. The University also offers a module in Resource Economics to Masters students within the Institute of Environment and Natural Resources.

Resource economics is offered as a module in the Masters of Human Geography at the University of Dar es Salaam. The University's Institute of Resource Assessment plan to run an environmental economics training short course for regional teachers of resource economics in late 1998.

In Kenya, short modules in resource economics are offered by the University of Nairobi to Economics Masters students and similar courses are offered at Kenyatta University to Masters students in Environmental Science.

NGOs:

The regional networking and capacity building initiative of the IUCN (NETCAB) funds several resource economics academic research contracts annually, has a Small Grants Fund for encouraging short-term fellowships and professional exchange in the region (in collaboration with USAID), and organises and funds regional workshops in resource economics. For example, six-week NETCAB courses on 'environmental economics and policy analysis' were recently held by Namibia's Department of Agricultural Economics and Extension. The Environmental Economics Network for Eastern and Southern Africa is another IUCN initiative to build capacity in the region. EENESA holds annual Policy Workshops in Natural Resource Policy Analysis which run for 10 days and cater for about 25 participants from the region (2 from each of the 12 countries). The workshop is aimed at mid-level civil servants from development ministries, finance ministries, NGOs etc. It is taught by Network members from the University of Botswana (Dr Jaap Arntzen, Dept Environmental Studies), the University of Zimbabwe (Margaret Chitiga, Dept Economics), the University of Natal, Durban (Prof. A.B. Lumby, Dept Economics & Management) and the University of Pretoria (Prof Rashid Hassan, Dept Agricultural Economics). Most EENESA funding is earmarked for these workshops, but they also have a Research Proposals Fund which invites resource economics research proposals from the region. Research proposals that qualify are supported up to USD 10 000 for a maximum of 12 months and these researchers also attend the Policy Workshops.

The Beijer Institute (Sweden) have funds from the MacArthur Foundation and the Swedish SIDA to carry out a Teaching and Training Programme in Environmental Economics aimed at building capacity among young university teachers in Economics in developing regions. Teaching workshops are followed up with Research Seminars for the same participants. They have held two African Teaching workshops (Malta 1993, South Africa 1997) and one is planned for Ghana in October 1998. They have also held three Research Seminars (Tanzania 1994, Malta 1995, Zambia 1998). Workshops and Research Seminars cater for about 20 participants for each occasion and are taught by international academic experts and active resource economics from multinational institutions such as The World Bank.

The International Society for Ecological Economics, University of Maryland, USA has held two short workshops over the last few years in ecological economics that have been well attended by a wide range of experts. These workshops tend to be issue-driven, focusing on specific ecological-economic interactions, but have been very successful in bringing together multidisciplinary teams to work on ecological economics problems, mostly through model building.

The South African Wildlife College runs an annual week-long course on the Economics of Wildlife Management and Protected Areas (10-12 students). Also aimed at mid-level civil servants, this course gives a brief overview of resource economics as applied to park management and conservation issues.

The South African Affiliate of IAIA (International Association for Impact Assessment) offers occasional training workshops and 1-week short courses in resource economics (e.g. Sept 1998) taught by overseas experts and aimed at people in the Environmental Impact Assessment field.

The Sustainable Development Centre of Uganda, with funding from World Bank EDI have run at least 3 environmental economics short courses for politicians and planners in Uganda over the last few years.

ACTS (the African Centre for Technology Studies) - based in Nairobi but serving the Eastern and Southern Africa region (Kenya, Tanzania, Uganda, Ethiopia, Malawi, Zambia), are currently running their first 3 month course on environmental economics.

In Zambia and Zimbabwe, there are several resource economists working in a private capacity or with NGOs, usually on specific resource utilisation projects or contracts. In Namibia, the Namibian Economic Policy Research Unit (NEPRU - an NGO) has some 8 or 10, occupied, general "Economic Researcher" posts, some of which are doing work on natural resources issues.

Government Sector

In the ZBWCRUP countries there are approximately 120 to 180 posts for formal economists in government Ministries and Departments that have some influence over environmental resources (e.g.. Environment, Agriculture, Water, Development, Rural Development, Tourism, Fisheries, Forestry, Mines and Minerals, Energy, etc.). This sector holds a large amount of the region's resource economics expertise and several institutions have managed to attract significant amounts of donor or other funds, and "critical masses" of expatriate and local staff, for ongoing research and capacity-building programmes. However, in many government institutions, resource economics skills are spread too thinly to have an impact. In addition, the trend seems to be that most economists recruited for these posts have pure economics degrees. If needed (e.g. post creation, restructuring to keep up with international trends) these economists tend to get specialist training only after obtaining some working experience. This is usually on short course at overseas institutions (often donor funded at very high costs) or a year-long diploma/degree.

The South African Department of Environmental Affairs and Tourism (DEAT) has formed an Environmental and Resource Economics Directorate which employs several economists with some resource economics training. This Directorate is in the process of developing national policies on Natural Resource Economics, its application as well as other issues such as National Accounting. Several workshops have been held and more are planned. Policy documents are disseminated for commentary through a fairly interactive process.

Some National and Regional Parks organisations(especially in South Africa) have resource economists as specialist post appointments.

A FRAMEWORK FOR THE ENHANCEMENT OF INSTITUTIONAL CAPACITY

To enhance human capacity (or expertise) in environmental and resource economics requires:

- Teaching institutions to develop curricula and degree courses, attract and train suitable students,
- Short courses to be offered at the appropriate level to the appropriate people, and
- The effective sharing of knowledge on current trends and developments in this field in Africa among those trained.

To enhance institutional capacity in environmental and resource economics requires:

- The creation of mass awareness of resource economics, its usefulness in environmental management and the results of its application (through popular media releases, short notes, short courses, policy briefs)
- The creation of a critical mass of advanced knowledge applicable locally (higher education and research)
- The facilitation of knowledge sharing (networking)
- The attraction of suitably qualified academic candidates (MSc and PhD level) with an interest in issue driven research locally and a willingness to take on postgraduate students in resource economics (i.e. academic post creation)
- The concentration of knowledge at appropriate centres (critical mass)
- Sufficient and continued funding of capacity initiatives (builds long-term capacity)
- The co-ordination of initiatives at a regional level (efficiency and forward planning)

At academic institutions, several hundred undergraduate students are trained each year in the region in pure economics with an introductory knowledge of resource economics. A similar number trained in general environmental management and conservation techniques are also exposed to some degree of introductory knowledge. A much smaller number gain exposure at the Masters level and it appears that almost all of these are only partially training in resource economics ancillary to other major thrusts such as Agriculture, Conservation Biology and Environmental Management. Most experts from the region with Masters degrees in environmental and resource economics obtained them at overseas institutions, particularly in the USA and the UK. Almost no PhD students in resource economics have been produced in the region to date and those with PhDs have been trained overseas.

The major current capacity building initiatives in the NGO sector seems to be the promotion of short courses and workshops (1 - 6 weeks) targeted at senior or line management (includes managers directly responsible for policy implementation, at department/section level etc). These tend to provide only an overview of basic resource economics and protected area management, valuation and cost benefit analysis techniques, financial analyses, the role of communities and other stakeholders in resource economics, land-use planning issues, tourism issues and policy and legal issues. While this increases the awareness of resource economics among environmental managers, it alone is not sufficient to meet the need for in-depth resource economics research. Initiatives also need to be developed that promote academic study in resource economics.

In the Government sector there tends to be a lack of critical mass in resource economics in many institutions. Resource economists in many of these organisations, including conservation agencies, reportedly spend much of their time working on conventional economic and financial issues rather than issues specific to natural resources. Some resource economists in the Government sector feel isolated and believe that the creation of resource economist's posts represents tokenism rather than a fundamental change in the thinking of their institutions. The availability of funding appears to be the factor limiting the creation of more than one post at many government institutions.

The greatest problem with current capacity building initiatives according to regional resource economists is the lack of participation by senior decision makers. Usually, line Managers or Chief Executives are too busy to attend short courses, even if they are invited. Thus it is usually the lower echelons of many organisations that end up attending as they tend to be less critical to the daily functioning of institutions. Hence, not too much resource economics expertise ends up being incorporated into mainstream management and this situation is unlikely to change for the next ten years if the ethos of senior management remains unchanged. The opinion of many experts currently working in the region is that capacity building needs to target these senior officials if initiatives are to be effective. Initiatives such as short courses have to actively solicit *senior* officials by making them more attractive to attend.

New capacity building initiatives are needed that specifically target senior management to invest them with the basic principles. These should be varied and *not* try and teach everything at once through a review as many current courses do. A better model would be several one-day courses over time on specific resource economics topics (e.g. valuation, incentives, CBS and decision-making etc.) to facilitate senior interaction with lower management who usually have a better working knowledge after completing standard one to three week short courses or basic degrees.

Another area of concern that needs to be addressed is that of effective networking. There *are* many regional experts with an interest and competency in this field who are largely unaware of most of the research and contract work being conducted. Simple networking as it is currently being conducted plays a role in maintaining capacity, but current initiatives are not sufficient. For example, many experts had not heard of current networks, or were ignorant of their function, despite being listed as network members. Networks should play a major role in information dissemination (new research, interesting papers, policy briefs etc.) as well as database maintenance (*up-to-date information*) and dissemination (e.g. updated and sent out annually or biennially).

Government sector employees usually deal with resource *management* issues on a daily basis in such a fashion that they do not require a technical knowledge of resource economics. Thus, while the current capacity building focus for this group is appropriate (apart from missing senior management), for regional expertise to develop in this field a critical mass of academic thinking is required as well as the development of techniques appropriate to the region. When compared to the so-called 'developed' world, we immediately notice the shortage of academically trained experts in Africa. New capacity building initiatives should focus on this particular problem in the next five years.

In this regard, South Africa has already made a start by providing specific bursary schemes for training in environmental and resource economics. In 1994, the Foundation for Research Development (FRD) offered 10 bursaries in resource economics for MSc/PhD students - currently 5 of these are represented in Table 2.1 as active expertise in this field in southern Africa. However, since then no new bursaries specific to this field have been offered by that institution and appropriate supervision for many of these bursary-holders has been a problem. Recently, there have been specific University posts created in Resource Economics (e.g. University of Pretoria) and several PhD students have enrolled under well-qualified supervisors. These initiatives partially explain the dominance of South African experts in the Expertise Database. Institutions involved in capacity building should consider making long-term bursaries (3-5 years) available to support masters and PhD level students in resource economics as an effective method of regional capacity enhancement.

The funding of pure academic research in this field is also a problem that needs addressing. There is certainly plenty of international and national funding available to do valuation studies for practical decision making or to drive policy changes, especially under convention clauses such as Agenda 21 and RAMSAR articles. However, almost no research money is made available for pure academic research on the theoretical advancement of methods through the normal grant mechanisms, and many academics lack the connections, skills or the time to solicit internationally funded project contracts.

Funding for posts, both in the academic and in the Public sector should be a priority for institutions involved in capacity building. For example, the Namibian Ministry of Environment and Tourism, Directorate of Environmental Affairs has an Environmental Economics Programme with proposed 3 government-funded posts within the new Ministry structure. Under the current structure there are no government funded posts, but there is a highly successful initiative with several short-term donor-funded positions on the programme, including two full-time and one part-time expatriate-occupied technical assistance positions, and four occupied donor-funded positions for Namibian economists. This is a constructive route for donors interested in capacity-building to follow as it allows these new ideas and methodological changes time to sink into a traditionally slow bureaucratic structure, and provides the funding to initiate studies which can demonstrate the usefulness of developing such capacity in-house

Such steps need to be actively promoted by agencies with vested interests in conservation and the correct application of resource economics tools in issues concerning conservation and development (land conversion). (e.g. the IUCN-NETCAB and EENESA, CIDA, CIRAD, WORLD BANK, GEF, WWF-I and WWF-Country Offices, National Government Departments of Environment, Tourism, Agriculture, Fisheries, Forestry, etc. and any Government institutions concerned with environmental use). Universities themselves should try to source funding for resource economist's posts, especially from National Science funding agencies (e.g. FRD) who should be encouraged support grants for research in resource economics by international NGOs.

The picture of current expertise and institutional capacity in the region that emerges from the discussion above is one of lack of co-ordination characterised by a lack of awareness about available resources at the disposal of environmental management agencies, investigating parties and prospective students. There appears to be a need for some major, coherent resource economics promotion initiative. One possible solution to this problem could be the establishment of a network of centres for resource economics research.

A regional network of centres for resource economics

The ideas that follow are based loosely on the organisational structure of many regional institutions elsewhere in the world that are formed to cater for specific issues, especially in new and emerging fields of knowledge. It is likely that several such centres are emerging in the region through private means even if one is not formally proposed by one of the core agencies suggested.

A typical centre could be funded by core funds from the IUCN/ World Bank/ WWF/ (other Environmental Development or Aid Agency), and yet would have the freedom to solicit its own additional funds through contract research. It would pull together a critical mass of 3-6 regional people with sound training in resource economics, but with a mix of backgrounds such as an ecologist/biologist, an agricultural economist, a conventional economist and a few postgraduate trained resource economists. This institution could perform the following functions:

1. Conduct original and contract driven research and analysis using resource economics;

2. Identify and conduct any resource economics research as required by the core donors/ funding institutions' own programmes that may require any resource economics components;

3. Aid in defining the role of resource economics and its usefulness in the region for policy development, decision-making and management;

4. Liaise with academic institutions on many issues:

- Funding: Try to source donor funding for proposed academic studies, as well as core funding for post-creation,
- Suitable Case studies: Identify suitable academic case studies in the region and the appropriate institution to approach with such studies,
- Provide guidance for potential students in resource economics as to choice of institution and field of study; and,

5. Maintain a *current* database of active experts in the region, including a synopsis of projects being worked on and resource economics inputs/ outputs to these.

Centres could liase with NGOs such as IUCN's EENESA and NETCAB to co-ordinate regional workshops and short course to ensure that they cover all topics in a useful sequential fashion. They could act as database centres for all other courses in resource economics in the region and academic courses available world wide. They could also co-ordinate funding applications for prospective students in resource economics and actively promote the development of such course components within existing institutions in the region through the managed exchange of experts and training workshops. Centres such as this need to be strategically placed in academic, NGO and/or government research or planning organisations. These will be able to attract the critical mass of expertise needed to make an impact and to specialise on local research problems, within a strong network.

ZBWCRUP PROJECT REQUIREMENTS FOR CAPACITY BUILDING IN WETLANDS VALUATION TECHNIQUES

- Field officers and other key members of the ZBWCRUP project, should read some of the core literature on wetlands valuation (e.g. Hollis *et al.* 1993, see References, chapter 8), including the

RAMSAR document on wetland valuation (Barbier *et al*. 1997) and this report. It is not the intent of this chapter to suggest that all participants in the ZBWCRUP need to be trained in resource economics. It is evident that the Field Project Officers are well acquainted with the underlying economics in their systems. However, if the broader project is to continue in the foreseeable future, it is recommended that the FPOs attend a short training course (EENESA/ SAWC style) to gain an understanding of the tools of resource economics which will enable them to initiate and manage long-term data gathering in a manner appropriate for the input into economic models and valuation methods.

- On-site training of enumerators and a thorough understanding by all involved (FPOs, local students and enumerators) of data requirements for specific techniques (e.g. Net Factor Income Models, CVM, Travel Cost) needs to be ensured during Phase II. A sound explanation of the underlying theory of the techniques to be applied must be made. The use of university students and/or parks and wildlife personnel to undertake short studies is recommended for Phase II.

- Specific economic valuation projects to be undertaken during Phase II should be offered to students at the various ZBWCRUP country institutions with sufficient capacity. For example, the University of Botswana could get a masters level student to work on tourism values in the Chobe-Caprivi, or the University of Malawi could get a masters student to work on the fisheries of Ndindi Marsh. Such projects would have to form the mini-dissertation of a coursework MSc as the timeframes would be no more than six months per study. The Conservation Biology masters students at the University of Cape Town would also be ideal for this task. Another option would be for the primary consultants to sub-contract out specific short-term projects to appropriate expertise at the ZBWCRUP country institutions. Either of these processes would be managed by the primary consultants but monitored by IUCN ROSA. The primary consultants would need to receive results well before deadline to incorporate them into the primary study. There is also the potential to acquire self-funded international students to work collaboratively with the primary consultants or local institutions on Phase II.

CONCLUSIONS

As the field of resource economics grows and becomes more “popularised” by the academic literature and actual case studies, we envisage a future swing in the universities of the region towards mainstream economics courses teaching longer, more in-depth modular sections on environmental and natural resource economics. A similar trend is likely for courses teaching traditionally pure environmental and biological sciences.

Already local universities appear to be following an international trend where traditional academic divisions are being broken down in keeping with the growing holistic approach to resource management. In the USA, most universities now have something analogous to a Department of Agriculture and Resource Economics, or a Department of Economics and Management, which would include degrees or degree components in resource economics. At the University of Namibia, a new Faculty of Agriculture and Natural Resources has been established and will offer courses in agricultural economics to science students. The University of Pretoria also has a new multidisciplinary university-wide postgraduate programme on environmental management (MSc level) with a strong economics component and an option for specialisation (in economics, biodiversity, wild life management, ecotourism, water and atmospheric pollution management, land use and resource optimisation).

Such long-term trends will certainly aid in introducing these concepts into the workplace of environmental management agencies and government ministries in the long-term, but the specific capacity building initiatives mentioned above are urgently needed in the short-term to meet the current demand and to get the necessary momentum going.

APPENDIX 1B

DATABASE OF RESOURCE ECONOMICS EXPERTISE IN AFRICA

Key:

Background (involvement, history and training in environmental and resource economics): C=Casual interest, I=In training, A=Academic, P=Professional, B=Biological sciences E=Environmental sciences, S=Social sciences, O=Other(explained), L=Largely self-taught, SC=Short courses/undergraduate courses, MSc degree, PhD degree, #=Number of years experience (since commencing training)

Experience (categorised as practical experience in economic valuation, including wetlands (econ-val-w), practical experience in economic valuation (econ-val), any other practical experience involving wetlands (wet) or simply general resource economics experience of some form (gen)

Countries/regions listed represent the geographical area of experience of the experts; a * denotes wetlands work in that country/region

Interest (represents the experts main field(s) of interest in environmental and resource economics):
1. Urban and environmental issues (e.g. pollution)
2. Policy
3. Water
4. Agriculture & land-use
5. Utilization of natural resources (including fisheries)
6. Conservation
7. Tourism
8. Valuation of natural resources
9. National accounting
10. Project appraisal and impact assessment
11. Other (explained)

Note: Some entries contain only the name and contact information of experts who did not respond to the survey but who are known to be working on resource economics issues in Africa.

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Background: P,S,MSc,11
Experience: wet
Madagascar, Indian Ocean Commission countries
Interest: 5,11(coastal zone management)

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Background: P,S,L,10
Experience: econ-val
southern Africa, east Africa, south Asia
Interest: 2,4,5,6,7,10,11(natural resources and rural livelihoods, community -based NRM)

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Background: I,P,B,E,SC,1
Experience: econ-val
South Africa (national scale)
Interest: 1,5,7,8

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Experience: econ-val, wet
Botswana*, Namibia*, Moçambique*, South Africa
Interest: 2,4,5,6,7,8,9,10,11(wildlife)

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Background: P,S,MSc
Experience: econ-val
West and southern Africa
Interest: 5,8,10

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Background: A,P,S,MSc,6
Experience: econ-val
South Africa, UK, USA
Interest: 1,3,4,5

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Background: I,A,P,E,O(geography, GIS & remote sensing),SC,MSc,2
Experience: wet (GIS database development, MCDM)
Kenya*, Uganda* (national GIS wetlands database)
Interest: 2,4,5,6,8,10,11(institutional frameworks and environmental information systems)

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Experience: econ-val
Zimbabwe, Namibia
Interest: 2,3,4,5

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Experience: econ-val
South Africa (national data)
Interest: 8,9,10

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Background: P,S,PhD,8
Experience: econ-val-w, wet
Zimbabwe*, Lesotho, southern Africa
Interest: 1,4,5,8

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Malawi
Interest: 1,2,4,5,8,10

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Background: P,E,O(agricultural economics),BSc(ag econ),PhD,14
Experience: gen
Zimbabwe (CAMPFIRE), Kenya, Botswana, Moçambique, Zambia (Luangwa Integrated Resource Development Project)
Interest: 2,4,5,6,7

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Background: C,A,P,O(forestry & wildlife),MSc,5
Experience: econ-val
Moçambique
Interest: 2,4,5,7,8

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Interest: 3,4,8,10

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Netherlands*, Bukino Faso, Mali, Tchad*, Moçambique (incl. economic valuation of Maputo elephant reserve)*
Interest: 5,6,8

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Zimbabwe, Zambia, Malawi
Interest: 4,5

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Interest: 2,3,4,5,7,8,10

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South Africa, Moçambique, Zimbabwe
Interest: 6,7

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Interest: 5,8,9

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Interest: 2,4,5,6,7,8,10

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Interest: 1,2,4,5,6,10

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USA, Lesotho
Interest: 2,3,4,5,8

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Interest: 3,4,5,6,7,8,10

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Interest: 2,3,11(International river development and administration)

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Tanzania (forestry vs wetlands)*, USA
Interest: 2,5,8

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Interest: 3,4,5,6,8,10

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Interest: 2,5,6,8,10

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Zimbabwe, Lesotho
Interest: 4,5

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Interest: 2,4,6,7

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South Africa, Ethiopia, Sierra Leone*, Europe*
Interest: 4,6,8,10,11(potential for a joint EU funded research projects?)

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Interest: 5,8,10

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Interest: 3,4,5,8,9,10

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Interest: 2,5,6,8

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Lesotho, Somalia, Niger, USA, Canada, Mexico
Interest: 5,8,10

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Honduras*, Peru*, Venezuela*, Guatemala*, USA*, Bonaire*, Mexico*, Congo Basin, Belize
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Interest: 5,6

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Interest: 2,4,5,6,8,9,10

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Namibia*, Botswana*, Zambia*, Malawi*, Moçambique*, South Africa
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Interest: 5,8,10

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Namibia*, Botswana*, Zambia*, Malawi*, Moçambique*, South Africa, Kenya, Mauritius Interest: 2,3,4,5,6,7,8,9,10,11(protected areas)

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APPENDIX 2.

HOUSEHOLD SURVEY INSTRUMENT

INTRODUCTION

Hello, my name is _________ and this is my colleague _________. We are from the IUCN in Marromeu. We are in this area doing a survey for the IUCN about how people use the wetland for their livelihood. (Show letter).

We would like to talk to the head of your household, if possible. (If the head is not present, ask to talk to next most senior person, e.g. wife or son. Aim to have adult members of both sex present.)

This interview will take about an hour and a half of your time. The information you give us will be completely confidential. (Get agreement to the interview. If they don't agree, thank them and move to next household.)

(Make sure everyone is settled and comfortable.) The purpose of this discussion is to find out more about how your household uses wetland resources. Your input, along with other households, will help us better understand how important wetland resources are to the people of this area. In the end we hope that our findings will help the communities and their leaders make the best decisions about how to manage these resources in the future.

When we ask a question about things you do, we are really interested in you as well as all the other members of your household. For example, if we ask "do you fish", we mean you or your brother or your son or any other person in this household.

A. QUESTIONS ABOUT THE HOUSEHOLD

(Ask and write down name of household family, and positions in household of those present at interview - e.g. induna, wife, son.)

1. How many adults are part of your household? (Explain that this includes people that are part of the household, but not part of the family, such as workers.)
2. How many of these adults spend all or a lot of time away?
3. How many adults in the household are too old to work or are unable to work for some other reason? (work means either employment or subsistence work)
4. How many children are there in this household? How many of them are under 8?
5. How many people are there in this household, including both children and adults?

B. RELATIVE VALUE OF HOUSEHOLD PRODUCTION

Over the whole year, in your daily life, your household may gain benefits from these things (put sheets of paper on the ground for each):

Crop production – for consumption by your household and for selling
Livestock - meat, milk and eggs for household consumption, and for sale
Natural resources in the uplands – such as poles for building, fuelwood, food plants and animals
Fish and crustaceans – for eating and for selling

Other natural resources in the wetland and floodplain – such as mangroves, palms, reeds, thatch grasses, food plants and animals and birds

Cash income - from jobs, part-time work, remittances from family members, pensions etc.

These beans are to show how much your household benefits from each thing. Benefits could be to use it, or to sell it, or just to enjoy it. If you get a lot of benefit, then we would show this by putting a lot of beans. (Place approximately equal quantities of beans on each paper.)

Would you say that this is true – that you get the same benefit from each of these sources? (Answer should be no. Ask the respondents to rearrange the beans appropriately themselves. They can discuss it - help them a little. Finally, get the note taker to count the beans.)

C. WETLAND RESOURCES

We would like to know all about the natural resources your household harvests annually from the wetlands and floodplains and coast, including what you do with them. We are going to ask you about several different types of resources, one by one. (Stress that you are only talking about wetland, floodplain and coastal resources, and not resources from the uplands.)

C1. CRUSTACEANS (Prawns, crabs etc)

1. Do members of your household catch prawns or crabs or other crustaceans? (y/n). (If no, go to question 10. If yes, then ask:)

When do you catch them? (time or circumstance.)

2. How much did your household catch in the last year?
3. What fishing equipment do you use? If you bought these things, what did each one cost? If you made each one, how long did it take? How often do you replace each thing?
4. How much does one person catch in a week in the peak fishing season? How much does one person catch in a week in the rest of the year?
5. In the peak season, how many days per week do people in your household catch crustaceans? How much time does one person spend fishing *per day* when they go out in the peak season?
6. How many days per week do people in your household spend catching crustaceans during the rest of the year? How much time does one person spend fishing *per day* when they go out in the rest of the year?
7. How far do you go to get crustaceans? Who does the fishing: the men, women, elderly, or children?
8. How much of your catch comes from the sea, how much from the coastal estuaries and mangroves, and how much from the river and floodplain.
9. Did you sell any crustaceans in the last year? (If answer is yes, ask:) How much?
10. Did you buy any crustaceans in the last year? (If answer is yes, ask:) How much?

C2. FISH

1. Do members of your household catch fish? (y/n). (If no, go to question 10. If yes, then ask:)
2. When do you fish? (time or circumstance.)
3. How much fish did your household catch in the last year?
4. What fishing equipment do you use? If you bought these things, what did each one cost? If you made each one, how long did it take? How often do you replace each thing?
5. How much fish does one person catch in a week in the peak fishing season? How much fish does one person catch in a week in the rest of the year?
6. In the peak fishing season, how many days per week do people in your household fish? How much time does one person spend fishing *per day* when they go out in the peak fishing season? How many days per week do people in your household fish during the rest of the year? How much time does one person spend fishing *per day* when they go out in the rest of the year?
7. How far do you go to fish? Who does the fishing: the men, women, elderly, or children?

8. How much of your catch comes form the sea, how much from the coastal estuaries and mangroves, and how much from the river and floodplain.
9. Did you sell any fish in the last year? (If answer is yes, ask:) How much fresh? How much dried or smoked?
10. Did you lose any fish nets or fish to crocodiles, hippos or other wild animals in the last year? (Get details).
11. Did you buy any fish in the last year? (If answer is yes, ask:) How much? (Amount bought in last year, in amounts or numbers of fish). When do you buy fish? (time or circumstance).
12. Were you able to obtain enough <u>fish and crustaceans</u> altogether for your own household use for the last year
    (Y/n; add any comments they have.)

C3 PALM & MANGROVE WOOD

1. Do you ever harvest palm or mangrove wood? (y/n). (If the answer is no, go to question 8). Which species are harvested? (get English and local name)
2. How much did your household collect in the last year? (Establish quantity, and what unit of collection, e.g. poles). If they use both palms and mangroves, get separate information for each, for this and the following questions.
3. When is it usually collected during the year?
4. Who harvests the wood?
5. How much does one person collect in one trip?
6. How far do you normally travel to harvest mangrove wood? How much time does it take you to get there, harvest it and get back? How do you transport it?
7. Did you sell any mangrove wood in the last year? (If yes, ask:) How much?
8. Did you buy any mangrove wood in the last year? How much? (Write how much they bought in the last year, and also write the units of collection.)
9. Were you able to obtain enough altogether for your own household use for the last year?
   (Y/n; add any comments they have.)

C4. PALM FRONDS & SAP

1. Do you ever harvest palm fronds or sap? (y/n). (If the answer is no, go to question 7. If yes, then ask). Which palms are harvested and when? (get English and local name, get time or circumstances.)
2. How much did your household collect in the last year? (Establish how many, and what unit of collection, e.g. fronds, litres)
3. How many fronds or how much sap does one person collect in one trip?
4. How many trips did people in your household make *in one month* to harvest fronds or sap during the time you were harvesting? Are these trips made by men, women, elderly, or children?
5. How far do you normally travel to harvest fronds or sap? How much time does it take you to get there, harvest it and get back?
6. Did you sell any fronds or raw sap in the last year? (If yes, ask:) How much? (Amount sold in last year, in units of collection, <u>not</u> including any sold in processed form.)
7. Did you buy any fronds in the last year? How much? (Write how much they bought in the last year, and also write the units of collection.)
8. Were you able to obtain enough altogether for your own household use for the last year?
   (Y/n; add any comments they have.)

C5 REEDS (INCLUDING PAPYRUS)

1. Do you ever harvest Reeds or Papyrus? (y/n). (If the answer is no, go to question 7. If yes, then ask:). Which species are harvested and when? (get English and local name, get time or circumstances.).
2. How much did your household collect in the last year? (Establish how many, and what unit of collection, e.g. bundles, and the size of units, e.g. 30 cm diameter, number of stems)
3. How much does one person collect in one trip?
4. How many trips did people in your household make *in one month* to harvest reeds or papyrus during the time you were harvesting? Are these trips made by men, women, elderly, or children?
5. How far do you normally travel to harvest it? How much time does it take you to get there, harvest it and get back? How do you transport it?
6. Did you sell any in the last year? (If yes, ask:) How much? (Amount sold in last year, in units of collection, <u>not</u> including any sold in processed form, e.g. mats.)
7. Did you buy any reeds or papyrus in the last year? How much? (Write how much they bought in the last year, and also write the units of collection.)
8. Were you able to obtain enough altogether for your own household use for the last year? (Y/n; add any comments they have.)

C6 GRASSES

1. Do you ever harvest grasses from the wetlands and floodplain? (y/n). (If the answer is no, go to question 7. If yes, then ask:). Which species are harvested and when? (get English and local name, get time or circumstances.)
2. How much did your household collect in the last year? (Establish how many, and what unit of collection, e.g. bundles; and the size of units, e.g. 30 cm diameter)
3. How much does one person collect in one trip?
4. How many trips did people in your household make *in one month* to harvest grass during the time you were harvesting? Are these trips made by men, women, elderly, or children?
5. How far do you normally travel to harvest grass? How much time does it take you to get there, harvest it and get back? How do you transport it?
6. Did you sell any grass bundles in the last year? (If yes, ask:) How much? (Amount sold in last year, in units of collection, <u>not</u> including any sold in processed form.)
7. Did you buy any grass in the last year? How much? (Write how much they bought in the last year, and also write the units of collection.) When is it bought? (time or circumstances.)
8. Were you able to obtain enough altogether for your own household use for the last year? (Y/n; add any comments they have.)

C7. FOOD PLANTS (e.g. vegetables and fruits)

1. Do you ever harvest food plants from the floodplain wetlands?(y/n). (If the answer is no, go to question 8. If yes, then ask:). Which species are harvested, and when? (get English and local name, get time or circumstances.)
2. How much did your household collect altogether n the last year? (Establish quantity, and what unit of collection, and the size of units)
3. How much does one person collect in one trip?
4. How many trips did people in your household make *in one month* to harvest food plants during the time you were harvesting? Are these trips made by men, women, elderly, or children?
5. How far do you normally travel to harvest food plants? How much time does it take you to get there, harvest it and get back?
6. Did you sell any food plants in the last year? (If yes, ask:) How much? (Amount sold in last year, in units of collection, <u>not</u> including any sold in processed form.)

7. Did you buy any wild foods in the last year? How much? (Write how much they bought in the last year, and also write the units of collection.) When is it bought? (time or circumstances.)
8. Were you able to obtain enough vegetables (own or bought) and wild food plants altogether for your own household use for the last year?
(Y/n; add any comments they have.)

C8. WETLAND ANIMALS AND BIRDS

1. Do you ever harvest **animals or birds from the floodplain and wetlands**? (y/n). (If the answer is no, go to question 8. If yes, then ask:). Which species are harvested and when? (get English and local name, get time or circumstances.)
2. How many did your household collect in the last year?
3. How many does one person collect in one trip?
4. How many trips did people in your household make *in one month* during the time you were hunting? Are these trips made by men, women, elderly or children?
5. How far do you normally travel to hunt? How much time does it take you to get there, hunt, and get back?
6. What equipment do you use to hunt or transport animals and birds**?**
7. Did you sell any wild meat in the last year? (If yes, ask:) How much?
8. Did you buy any wild meat in the last year? How much? (Write how much they bought in the last year, and also write the units of collection.) When is it bought? (time or circumstances.)
9. Were you able to obtain enough meat altogether for your own household use for the last year? (including domestic meat from chickens, cows etc, own or bought) (Y/n; add any comments they have.)

D. LIVESTOCK

1. Do you have chickens or other domestic fowl? How many? (If none, then skip to next section)
2. Do you have goats, sheep or pigs? How many of each?
3. Do you own cattle? How many? How many bulls? cows? oxen? steers? heifers?
4. How many of the cows are milking?
5. Which members of the household tend the cattle? How many people tend the cattle each day? How much time does each person spend tending cattle per day? Do you pay anyone to tend your livestock? (If yes, ask:) How much? (Write the amount of money and the time, such as K150/month.)
6. What livestock did you buy and sell in the last year? How many were slaughtered for your own household use? (Detail for each type of livestock)? How many animals died during the last year (if any, get the type e.g. chickens, bulls, cows, oxen)?

E. CROPS

1. What is the total area of your cultivated fields? (Note units, e.g. hectares)
2. How much time was spent by members of your household in growing your crops in the last year? (Explain that this means ploughing and planting, tending the fields and harvesting crops - get number of people and period of time for each activity, e.g. 4 people for 2 weeks planting.If oxen were used, also give the number of people and the time they spent.) How much of this work was done by men, women, children and elderly?
3. Did you hire oxen to plough your fields in the last year? If so, for how much (in money or other units)?
4. Did you lose any crops to wild animals in the last year? (Give details.)
5. In poor crop years, do you buy more food? (Get them to explain.)
In poor crop years, do you use more wetland resources? (Get them to _tell you which ones they use, and whether they are for their own use, or for exchange for money or food.)

6. How much money did your household spend on food in the last year?
7. What crops, fruits, and vegetables do you grow? (Complete the crop table, add to the list if you need to, delete those not grown.)

(Ask all these questions for first crop listed, then ask questions for next crop listed, and then the next, until all have been completed.)

8. (For each item listed:) How much area is used for this crop? (This may add up to more than the total area above if there is serial cropping or double cropping.)
9. (For each item listed:) How much did you produce in the last year?
10. (For each item listed:) Was this enough to meet your household needs for eating for the year? (Y/n; add any comments they have.)
11. How much___(this crop) did you sell or exchange for other goods in the last year? What price or goods did you get for it?

F. ADDING VALUE: PROCESSING AND CRAFTS

People can use natural resources or crops to make things.
For example: wetland resources can be used to make bricks, pots, mats, baskets, fish traps.
Upland resources can be used to make carvings, furniture, baskets.
Crops can be used to brew beer, or make prepared food for sale.

1. Does anyone in your household use natural resources or crops to make things? What do they make? (List products. They might be things not mentioned in any of the lists above - ask about others not listed.)

(For each type of product, answer all the following questions on the product table before moving on to the next product:)

2. Who makes this product - men, women, elderly and children?
3. How many ____(finished product; note units) do members of your household produce in a year?
4. What material is used to make this product? (e.g. bundles of papyrus to make a mat, plus the string to tie it)
5. Where does the material for this product come from - wetland and floodplain resources that grow naturally; upland resources that grow naturally; or crops and livestock products?
6. What tools and equipment are used to make ____(this product) ? (e.g. the needle to sew it).
7. How long does it take to make ___ (one unit of this product)? (time in minutes, hours, or days to make one if working on it continuously. For beer brewing, we want only labour time.)
8. Do you make _____(this product) for your own household use? Do you sell it? (y/n)
9. When (time of year, season, circumstances) do you make _____(this product)?
10. Do you have to travel to sell ___? How long does the travel take? Would you make a trip only for the purpose of selling it?
11. Do you sell_____(this product) to earn a regular income? or just when you need extra cash for something special?
12. If you would be willing to tell us, we would like to know how much income you made from _____(this product) in the last year?

G. CASH INCOME

1. How many people in your household, who normally live here, have full time jobs? (Establish if these are men or women.)

2. How many people in your household, who normally live here, have part time work? How much time did they spend working during the last year? (Establish if these are men or women.)
3. How many members of your household live away from home but contributed money in the last year?
4. If you would be willing to tell us, we would like to know how much cash income your household made from pensions in the last year.
5. If you would be willing to tell us, we would like to know how much cash income your household made from working for money in the last year. (This does not include selling things they made or collected or caught, just work that someone paid them to do.)

APPENDIX 3.

FOCUS GROUP INSTRUMENTS: REPRESENTATIVE EXAMPLES

FOCUS GROUPS ON CROPS & LIVESTOCK
GRUPO FOCALIZADO NAS CULTUTAS e GADO

My name is ____and this is my colleague _____ who will be taking notes for us during this discussion. The purpose of this discussion is to find out more about agriculture in this community.
Chamo-me________ e este é o meu colega_______que irá tomar notas durante a nossa discussão. O objectivo desta discussão é saber mais sobre a agricultura nesta comunidade.

Your input will help us understand the value and state of the agricultural resources you have.
A vossa contribuicão ajudar-nos-à a entender o valor e o estado dos recursos agrícolas que vocês tem.

We are also asking other people about the use of natural resources in the wetland, and in the end we hope that all this information combined will help the communities and their leaders make the best decisions as to how to manage all of the wetland resources in the future.
Temos estado a perguntar outras pessoas sobre o uso dos recursos naturais nas terras húmidas e esperamos o que conjunto da informacão final obtida venha a ajudar as comunidades e seus líderes na tomada de decisões e no saber fazer o maneio de todos os recursos das terras húmidas no futuro.

(Address to the group:) Please could you introduce yourselves. (Record information on data sheet.)
(Dirigido ao grupo:) Podem apresentar-se, por favor? (Registo das informacões na folha de dados).

1. What types of crops are grown in this area, and what types of livestock are kept? *Que tipo de culturas são produzidas nesta área? E que tipo de animais são criados?*

2. We would like you to describe which crops are grown in various parts of the wetlands and floodplain. Please describe which crops are grown (a) in flood water, (b) in wetland after floodwaters recede (c) in the floodplain, but in areas that are very seldom flooded (d) only above the floodplain, in the uplands.
Gostariamos que vocês nos descrevessem as culturas que crescem nas diferentes zonas das terras húmidas (onde em relacão ao canal principal e em relacão as zonas inundadas nos tempos das cheias). Por favor, descreva as culturas:

a) Nas águas das cheias
b) Nas terras húmidas depois das aguas das cheias baixarem
c) Na zona das cheias, mas nas areas raramente inundadas.
d) Apenas nas terras altas, acima da zona das cheias.

3. In the community, **which** are the best agricultural lands?
Quais são as melhores terras agricolas, nesta comunidade?

4. How do different levels of flooding affect crops? For example, a high flood might be bad this year if it drowns crops, but might be good in later years due to increased fertility from the flood waters. Are there any other year to year factors that have a major effect on crop success (such as low rainfall, locusts, etc.)

Como é que os diferentes níveis das cheias afectam as culturas? Por exemplo, alto nível das cheias pode ser prejudicial este ano, porque afogará as culturas, mas pode ser benéfico para os anos vindouros através do incremento que dará a fertilidade das terras. Existem outros factores anuais com grande impacto no successo das culturas (tais como pouca chuva, gafanhotos, etc)?

5. Where are **cattle** grazed? **Everywhere or in certain types of areas?** Which are best?
A pastagem é feita em certas áreas ou em todas as áreas? Quais são as melhores áreas?

6. How much time do cattle spend in each of (a) wetland area which were wet after waters recede (b) in the floodplain, but in areas that are very seldom flooded (c) above the floodplain, in the uplands and (d) in crop stubble fields.

Quanto tempo o gado leva:
a)a área que esteve inundada, depois de as águas baixarem?
b)Na zona das cheias, mas em áreas raramente inundadas?
c)Além da zona das cheias, nas zonas altas?
d)Nas zonas de capim curto?

7. **Do you burn for grazing**. What area is burned, where (e.g. reedbeds?), and in what months?
Vocês fazem queimadas ao servico da pastagem? Quais são as áreas nas quais as queimadas são practicadas?Onde , concretamente, nessas áreas (por exemplo, na juncada), e em que meses?

8. Is there more livestock disease associated with wetland **or** upland? If so, please describe.
Tem surgido mais doencas associadas às terras húmidas ou doencas associadas às terras altas?Se tal tem acontecido, descreva a situacão.

9. How does the number of cattle in the herd vary during the year?
Como é que o número de animais na herdade varia ao longo do ano?

10. We would like you all to describe the rules governing agriculture and livestock.
Gostariamos que vocês nos descrevessem os regulamentos da actividade agrícola e pecuária nesta comunidade.

(prompt the following questions/ *coloca as seguintes questões*) :

- how does a household gain access to preferred agricultural land **or grazing** areas? *Como é que uma familia ganha acesso as terras de cultivo ou pastagem preferenciais*
- What areas are restricted? *Quais são os terras restritas*?
- who monitors the use of different areas? *Quem controla o uso das diferentes áreas?*
- are there any rules about where you can sell your products, and how much can you charge? are there any other restrictions on selling crops **or livestock**? *Existe algum regulamento sobre onde vocês devem vender os productos agricolas ou pecuários e os precos que vocês devem paraticar? Existem outras restricões na venda dos produtos?*
- what if rules are violated? *O que acontece quando os regulamentos são violados?*
- do conflicts arise and how are they handled? *Tem surgido conflitos durante o processo de comercializacão? Como é que tem sido resolvidos*?

11. When are crops planted, cultivated, and harvested? (Facilitator should complete the crop calendar, using participants' descriptions, showing planting, tending, and harvest times.)

Quando é que as culturas são plantadas, cuidadas e colhidas? (Usando as descricões dos participantes, o facilitador deverá completar o calendario das culturas, no qual os periodos de plantio, cuidados e colheita estão demarcados).

12. Given this pattern of growing crops, how many people and how much time is spent in each activity, for each crop? (Facilitator should lead discussion to make sure all crops and activities are discussed.)

Dados estes padrões de decurso de crescimento das culturas, quantas pessoas são envolvidas e quanto tempo é despendido em cada cultura? (O facilitrador deverá liderar a discussão, para ter a certeza de que todas as culturas e as correspondentes actividades estão cobertas).

13. Does **cattle** tending effort vary through the year? If so make a calendar of relative amounts of work. **Who tends the cattle and other livestock?**

O esforco nos cuidados com o gado varia ao longo do ano? Se varia, faca o calendário de variacão do trabalho ao longo do ano. Quem cuida do gado e outros animais domésticos?

14. Which people harvest crops - men, women, elderly, children, everyone? Do they use different methods?

Quem faz a colheita- (homens, mulheres, idosos, criancas, todos)? Usam todos o mesmo metodo?

15. What equipment do you use in crop cultivation? How much does each of these things cost? How long does each of these things last? Are any of these things shared among more than one household?

Que intrumentos vocês usam no vossa actividade agricola? Quanto custa cada instrumento? Quanto tempo dura cada um dos instrumentos? É algum dos instrumentos partilhado por mais de uma casa?

16. How much does each type of crop sell for after harvest and before harvest? (specify currency and units clearly; get a proper detailed description of the unit if necessary).

Por quanto é que vendem cada tipo de produto, antes e depois das colheitas? (Especificar a moeda e unidades de troca claramente. Obter descriccão detalhada da unidade de troca se necessário)

17. Where do you sell your crops?

Onde é que vocês vendem os vossos produtos?

18. How much are animals bought and sold for? What are the high and low prices, and when would those prices happen? (Note amount of money and units in which sale is measured, e.g. one animal, kg. of meat etc.; get a proper detailed description of the unit if necessary).

Por quanto é que os animais são vendidos? Quais são os precos mais altos e baixos practicados? Quando é que tais precos acontecem? (Anotar quantia em dinheiro e unidade de medida, por exemplo, um animal, kg de carne, etc. Descrever detalhadamente a unidade de medida se tal for necessário)

19. How much milk do you normally get from a cow per day? How much would it cost you to buy a litre of milk locally?

Quanto leite por vaca vocês obtem diariamente? Quanto é que custa a compra de um litro de leite localmente?

20. Have **crop** yields per unit of land changed over the last 5 years? (Get them to quantify this with beans: put approximately equal quantities of beans in each square. Explain this is what no change looks like. If this is not true, then they can rearrange accordingly.)

Ocorreu alguma mudanca na producção das culturas por unidade de terra nos ultimos 5 anos? (O facilitador poderá orientar a quantificacão usando o feijao: colocar quantidades de feijão aproximadamente iguais por area. Explicar que isto é mais ou menos o que "mudanca" significa. Se tal não corresponder à verdade, eles farão um rearranjo.)

21. (Address older members) Have yields per unit of land changed over the last 20 or 30 years? (Method as above.)

(Colocar esta aos participantes mais velhos) Ocorreu alguma mudanca na producão por unidade de terra nos últimos 20 ou 30 anos? (Usar a metodologia em 12).

22. What do you think are the causes of these long term trends? (e.g. shorter fallow period due to too many people and too little land.)

O que é que vocês apontam como causas destas mudancas a longo termo (usar a palavra prazo se linguagem comercial for pretendida)?

23. If the trend is negative/problematic: What would you recommend as the solution?

(*Se a tendência é negativa ou problemática): O que é que vocês recomendam como solucão*?

24. What has changed about cattle keeping in the last 20 years? If problems, suggest solutions.

O que é que mudou nos cuidados com o gado nos últimos 20 anos? Se ocorreram mudancas problemáticas, que solucões vocês sugerem?

FOCUS GROUPS on FISH/ANIMAL RESOURCES.
GRUPO FOCALIZADO NO PEIXE E ANIMAIS SELVAGENS

My name is ____and this is my colleague _____ who will be taking notes for us during this discussion. As you know, we are from the IUCN in Marromeu.
Chamo-me_________e este é o meu colega________________que irá tomar notas durante a nossa discussão. Como é do vosso conhecimento, nós somos da IUCN em Marromeu.

The purpose of this discussion is to find out more about ______ (e.g. use of fish/ animals) in this community. Your input will help us understand the value and state of this resource. We are asking different people about different resources, and in the end we hope that our findings will help the communities and their leaders make the best decisions as to how to manage these resources in the future.
O objectivo desta discussão a procura de mais conhecimentos sobre__________(recurso em causa) nesta comunidade. A vossa contribuicão ajudar-nos-à a entender o valor e o estado do recurso. Temos estado a perguntar outras pessoas sobre os diferentes recursos e esperamos que o conjunto da informacão final obtida venha a ajudar as comunidades e seus líderes na tomada de decisões no maneio de todos das terras húmidas no futuro.

1. When we say "the resource" we mean all the resources we are talking about in this workshop
Designamos “recurso” a todos os recursos de que falamos neste workshop.

(Address to the group:) Please could you introduce yourselves. (Record info on data sheet.) (*Dirigida ao grupo) Podem apresentar-se, por favor*?

2. We would like all of you to describe the resource and its uses to us, so everyone here is clear on what we are going to be talking about. What we are trying to find out is:
- what different species are used. Please note English and Local names if possible.
- what component of the resource is used? (e.g. just mature stems, roots, whole plant, etc.)
- what is the resource used for? (e.g. mats, courtyards, baskets, pots)

Gostariamos que vocês descrevessem o recurso e a sua utilidade. Desta forma, “de que é que estamos a falar”, será algo claro para todos. O que estamos procurando saber é:
-Quais são as espécies de peixe a animais utilizadas pelas pessoas desta comunidade? (Anotar nomes em Português sempre que possível).
–Que componente de cada espécie é utilizada é utilizada?(carne, ovos, mel, penas,etc).
–Para que fim é o recurso usado? ? (exemplo, carne para comer, cornos para a medicina tradicional, etc.).

3 Does availability of the resource change over the seasons? (If no, go on to question 5.) *A disponibilidade do recurso varia ao longo do ano? (Se não, vá a questão 5.)*

4. Could you describe how the water level changes over the year (flooding, flooded, subsiding, channels only), then describe how the availability of the resource changes (use a pile of about 200 beans for the second part of the question. The reason for asking about flooding first is that some people may think in terms of flood pattern rather than months.)
Gostariamos que vocês descrevessem a variacão do nível das águas ao longo do ano (“inundando as terras”, “terras inundadas”, “água apenas nos canais”). Podem em seguida fazer o favor de descrever como a disponibilidade do recurso varia ao longo ada ano (usar um monte de cerca de 200 feijões para a segunda parte da questão. A razão que leva a colocacão da questão sobre a variacão do nível das águas em primeiro lugar está na facilitacão do processo de contagem do tempo. Assume-

se que parte das pessoas presentes, no lugar de meses, usa eventos marcantes como ocorrência das cheias para medir o tempo).

5. We would like you all to describe where the resource is found in the local area.
(Facilitator should draw a map, using participants' descriptions. Facilitator should try and get some reference points on the map that will be useful for spatial scale, e.g . name and location of next village, and main channel Zambezi.)
Gostariamos que descrevessem a distribuicão dos recursos nesta área.
(O facilitador deverá orientar o esboco de um mapa pelos participantes, no qual pontos de referência e escala espacial deverão ser definidos, por exemplo, distância em relacão à povoacão mais próxima e em relacão ao canal principal do Zambezi).

6. We would like you all to describe the rules governing access to, and use of this resource.
(Facilitator should prompt the following questions:)
Gostariamos que vocês descrevessem os regulamentos de acesso e uso deste recurso.
(O facilitador deverá colocar as segunites questões)

- How does a household gain access to preferred areas? (refer to map again if relevant, to show the areas mentioned.) *-Como é que uma casa ganha acesso ás áreas preferenciais (nas quais o recurso pode ser obtido)? (utilizar o esbocado mapa se tal se tornar necessário).*
- What areas are restricted? *-Quais são as áreas restritas? (assinalar as áreas restritas no mapa se tal for relevante)*
- Who monitors the use of different areas? *-Quem controla o uso das diferentes áreas?*
- What happens if the rules are violated? *-O que acontece quando o regulamento é violado?*
- Do conflicts arise and how are they handled? *-Tem ocorrido conflitos? Se sim, como tem sido resolvidos?*

(Note that for illegal activities you will have to convince the group to give honest answers to the following qestions):
(A resposta as questões que se seguem poderá envolver a mencão a actividades ilegais. O facilitador deverá convecer os participantes a dar respostas honestas)

Now in this discussion we are not worried whether or not you follow these rules. We want you to describe it exactly how it is!
Na parte da discussão que se segue, nós não estamos interessados em saber se vocês tem violado ou não os regulamentos. Gostariamos que vocês descrevessem a situacão tala e qual ela é.

7. How do you harvest this resource? If there are different methods, which is most important? next most important? etc.
Como é que vocês pescam/cacam este recurso? Se existem diferentes métodos qual é o mais usado? Qual é o segundo mais usado? Qual é o método que gostarriam de usar? Explique porque é que não podem usar o método gostaria.

8. Are different harvest methods used at different times of year? Describe.
Existem métodos diferentes de pesca/caca ao longo do ano? Se sim, descrevam tal variação.

9. What resources do you harvest using this method?
Quais são os recursos que vocês pescam/cacam usando este método?

10. What equipment do you use to harvest this resource? How much do each of these things cost? How long do each of these things last? Are any of these things shared among more than one household?
Que instrumentos usam para a pesca/caca deste recurso? Qual é o preco de cada um dos instrumentos? Qual é a duracão de cada um dos instrumentos? Existe algum instrumento cujo uso é compartilhado por mais de uma casa?

11. Who harvests this resource - men, women, elderly, children, all? Do they use different methods?
Quem pesca/caca este recurso? (homens, mulheres, idosos, criancas, todos). Usam todos o mesmo método?

12. You already told us when this resource is available (show beans as before.) Now we would like to know how much work people do to harvest it at the different times of year. Perhaps they work at getting it when it is most available, or perhaps they get it at a different time because of other reasons, such as the water is too high, or the people need to harvest crops or do something else. Please show how much work harvesting people do at the different times of year. (Do another row of beans.)
Já falamos acerca da variacão da disponibilidade dos recursos ao longo do ano. Agora gostariamos que vocês descrevessem a variacão da quantidade de trabalho dedicado a pesca/caca deste recurso ao longo do ano.Pode acontecer que, no lugar de se dedicarem à pesca/caca na época de abundância, as pessoas o facam fora da época, por razões diversas, tais como existência de actividades prioritárias ou condicões de pesca/caca dificultadas pelas cheias.Descrevam, por favor, a variacão da quantidade de trabalho dedicado à pesca/caca ao longo do ano (colocar outra coluna de feijões).

Finally, we would like to know when people get the most of this resource. Perhaps they get more when there is more, or perhaps they get more when they work harder, or perhaps at some times there is not so much even when people work hard. Do they get the most here, here, or here? (show on bean paper and point to time of most effort, time of least effort and time of some inbetween effort). When do they get the least?
Gostariamos também de saber quando é que as pessoas colectam/cacam mais este recurso. Pode acontecer que eles pesquem/cacem mais quando a disponibilidade é grande ou baixa. As pessoas pescam/cacam mais aqui ou ali? Quando é que pequena quantidade é obtida? (Pode-se usar o feijão para ilustrar a variacão de esforco com a abundante, escassa e intermédia disponibilidade do recurso).

13. How much do you get during these three times (peak, low, in between) for the amount of work you do (not counting the time it takes to go to the resource area)
e.g. one gill net set overnight catches 3 buckets of bream
e.g. fishing with a line for two hours catches 4 barbel.)
Descrevam o rendimento no trabalho durante os três períodos do ano (de abundância, de escassez e intermédia). Citaremos alguns exemplos para esclarecer a questão:
Exemplo 1: pesca a anzol durante duas horas rende 4 peixes da espécie Y
Exemplo 2: o emalhe nocturno rende 3 baldes de peixe

14. Do you harvest this resource in different places at different times of the year?
Durante os diferentes períodos do ano, vocês pescam/cacam este recurso em diferentes áreas?.

15. How much can you sell this resource for locally? (get amount of money and units of resource sold clearly.Get a proper detailed description of the unit if necessary, e.g. 1lb. of fuelplant for MT 7000).
Por quanto é que vocês podem vender este recurso localmente? (Descrever quantidade em dinheiro e unidade de medida do recurso calaramente, por exemplo, 1 lebre por 7 000,00 MT)

16. If you can't get enough of this resource, what do you use instead? If it is used for several purposes, do you use different substitutes for each purpose? Do you collect the substitute? If you buy it, how much does the substitute cost? (get amount of money and units of resource clearly).
Qual é o recurso alternativo que vocês usam quando não conseguem pescar/cacar quantidade suficiente deste? Quando o recurso que escasseia tem uma série de usos, vocês usam substitutos diferentes para cada propósito? O recurso alternativo é comprado ou pescado/cacado? Se é comprado, quanto é que custa? (dinheiro e unidade de medida descritos).

17. Does the availability of this resource change from year to year due to reasons other than the flooding? What do you think these reasons are?
Existem factores que contribuem para a variacão da disponibilidade deste recurso de ano para ano, que não sejam as cheias? Na vossa opinião, quais são os factores?

18. To everyone: can you recall changes in availabilty over the last 5 years? (This may be a combination of degradation and flood levels. Get them to quantify this with beans: put approximately equal quantities of beans in each square. Explain this is what no change looks like. If this is not true, then they can rearrange accordingly.)
Gostariamos que vocês descrevessem a variacão da disponibilidade dos recursos no últimos 5 anos (pode ser a combinacão da degradacão e do nível das cheias. Coloque quantidades aproximadas de feijões em várias áreas de uma folha de papel. Diga-lhes que isto corresponde às mudancas que ocorreram. Se eles não estiverem de acordo farão um rearranjo).

19. (*Address this to the older members*:) Has the availability of the resource increased or decreased over the last 20 or more years?. (*Method as above*.)
(Aos participantes mais velhos) Ocorreu mudanca na disponibilidade do recurso nos últimos 20 anos? (usar o método acima).

20. What are the causes of these long term changes?
Quais são as causas destas mudancas a longo termo?

21. If the trend is negative/problematic: What would you recommend as the solution?
Se as mudancas ocorridas são negativas e/ou problemáticas: Que solucões é que vocês recomendam?

22. We have discovered that people use XX__(number of species) in this area. We would like to know how important it is to you to have XX ____. For example, if you could get the same amount of food from only YY __ (<<XX), would it matter to you if the other ZZ (difference) were lost or no loner there? (prompt short discussion and record comment
Ficamos a saber que as pessoas usam X____ (número de tipos de peixes, etc). Qual é a importância que a obtencão de X_____tem para vocês? Vocês se importariam de, no lugar de colectar/cacar X____, colectar Y___(outro recurso)? Registar comentários e encorajar uma discussão sobre possibilidades de fazer menor pressão sobre um determinado recurso através do uso de outro em simultâneo, ou através do uso de recurso alternativo.

FOCUS GROUPS on PLANT RESOURCES.
GRUPOS FOCALIZADOS NOS RECURSOS PLANTAS

My name is ____and this is my colleague _____ who will be taking notes for us during this discussion. As you know, we are from the IUCN in Marromeu.
Chamo-me_________e este é o meu colega________________que irá tomar notas durante a nossa discussão. Como é do vosso conhecimento, nós somos da IUCN em Marromeu.

The purpose of this discussion is to find out more about **the use of** ______ in this community. Your input will help us understand the value and state of this resource. We are asking different people about different resources, and in the end we hope that our findings will help the communities and their leaders make the best decisions as to how to manage these resources in the future.
O objectivo desta discussão a procura de mais conhecimentos sobre o uso de__________(recurso em causa) nesta comunidade. A vossa contribuicão ajudar-nos-à a entender o valor e o estado do recurso. Temos estado a perguntar outras pessoas sobre os diferentes recursos e esperamos que o conjunto da informacão final obtida venha a ajudar as comunidades e seus líderes na tomada de decisões e na saber fazer o maneio de todos das terras húmidas no futuro.

1. When we say "the resource" we mean all the resources we are talking about in this workshop
Designamos "recurso" a todos os recursos de que falamos neste workshop.

(Address to the group:) Please could you introduce yourselves. (Record info on data sheet.) *(Dirigida ao grupo) Podem apresentar-se, por favor?*

2. We would like all of you to describe the resource and its uses to us, so everyone here is clear on what we are going to be talking about. What we are trying to find out is:
- what different **species** are used and what for. Please note English and Local names if possible.
Gostariamos que vocês descrevessem o recurso e a sua utilidade. Desta forma, "de que é que estamos a falar", será algo claro para todos. O que estamos procurando saber é:
-Quais são os diferentes espécies utilizadas pelas pessoas desta comunidade (Anotar nomes em Português sempre que possível).
–Para que fim é o cada espécie usada?

3 Does availability of the resource change over the seasons? (If no, go on to question 5.)
A disponibilidade do recurso varia ao longo do ano? (Se não, vá a questão 5.)

4. Could you describe how the water level changes over the year (flooding, flooded, subsiding, channels only), then describe how the availability of the resource changes (use a pile of about 200 beans for the second part of the question. The reason for asking about flooding first is that some people may think in terms of flood pattern rather than months.)
Gostariamos que vocês descrevessem a variacão do nível das águas ao longo do ano ("inundando as terras", "terras inundadas", "água apenas nos canais"). Podem em seguida fazer o favor de descrever como a disponibilidade do recurso varia ao longo ada ano (usar um monte de cerca de 200 feijões para a segunda parte da questão. A razão que leva a colocacão da questão sobre a variacão do nível das águas em primeiro lugar está na facilitacão do processo de contagem do tempo. Assume-se que parte das pessoas presentes, no lugar de meses, usa eventos marcantes como ocorrência das cheias para medir o tempo).

5. We would like you all to describe where the resource is found in the local area.
(Facilitator should draw a map, using participants' descriptions. Facilitator should try and get some reference points on the map that will be useful for spatial scale, e.g . name and location of next village, and main channel Zambezi.)

Gostariamos que descrevessem a distribuicão dos recursos nesta área.
(O facilitador deverá orientar o esboco de um mapa pelos participantes, no qual pontos de referência e escala espacial deverão ser definidos, por exemplo, distância em relacão à povoacão mais próxima e em relacão ao canal principal do Zambezi).

6. We would like you all to describe the rules governing access to, and use of this resource.
(Facilitator should prompt the following questions:)
Gostariamos que vocês descrevessem os regulamentos de acesso e uso deste recurso.
(O facilitador deverá colocar as segunites questões)

- How does a household gain access to preferred areas? (refer to map again if relevant, to show the areas mentioned.) -*Como é que uma casa ganha acesso ás áreas na quais o recurso pode ser obtido? (utilizar o esbocado mapa se tal se tornar necessário).*
- What areas are restricted? -*Quais são as áreas restritas? (assinalar as áreas restritas no mapa se tal for relevante)*
- Who monitors the use of different areas? -*Quem controla o uso das diferentes áreas?*
- What happens if the rules are violated? -*O que acontece quando o regulamento é violado?*
- Do conflicts arise and how are they handled? -*Tem ocorrido conflitos? Se sim, como tem sido resolvidos?*

(Note that for illegal activities you will have to convince the group to give honest answers to the following questions):
(A resposta as questões que se seguem poderá envolver a mencão a actividades ilegais. O facilitador deverá convecer os participantes a dar respostas honestas)

Now in this discussion we are not worried whether or not you follow these rules. We want you to describe it exactly how it is!
Na parte da discussão que se segue, nós não estamos interessados em saber se vocês tem violado ou não os regulamentos. Gostariamos que vocês descrevessem a situacão tala e qual ela é.

7. What equipment do you use to harvest this resource? How much do each of these things cost? How long do each of these things last? Are any of these things shared among more than one household?
Que instrumentos usam para a colecta deste recurso? Qual é o preco de cada um dos instrumentos? Qual é a duracão de cada um dos instrumentos? Existe algum instrumento cujo uso é compartilhado por mais de uma casa?

8. Who harvests this resource - men, women, elderly, children, all?
Quem colecta este recurso? (homens, mulheres, idosos, criancas, todos).

9. You already told us when this resource is available (show beans as before.) Now we would like to know how much work people do to harvest it at the different times of year. Perhaps they work at getting it when it is most available, or perhaps they get it at a different time because of other reasons, such as the water is too high, or the people need to harvest crops or do something else. Please show how much work harvesting people do at the different times of year. (Do another row of beans.)
Já falamos acerca da variacão da disponibilidade dos recursos ao longo do ano. Agora gostariamos que vocês descrevessem a variacão da quantidade de trabalho dedicado a colecta deste recurso ao

longo do ano.Pode acontecer que, no lugar de se dedicarem à colecta na época de abundância, as pessoas o facam fora da época, por razões diversas, tais como existência de actividades prioritárias ou condicões de colecta dificultadas pelas cheias.Descrevam, por favor, a variacão da quantidade de trabalho dedicado à colecta ao longo do ano (colocar outra coluna de feijões).

Finally, we would like to know when people get the most of this resource. Perhaps they get more when there is more, or perhaps they get more when they work harder, or perhaps at some times there is not so much even when people work hard. Do they get the most here, here, or here? (show on bean paper and point to time of most effort, time of least effort and time of some inbetween effort). When do they get the least?
Gostariamos também de saber quando é que as pessoas colectam mais este recurso. Pode acontecer que eles colectem mais quando a disponibilidade é grande ou baixa. As pessoas colectam mais aqui ou ali? Quando é que pequena quantidade é obtida? (Pode-se usar o feijão para ilustrar a variacão de esforco com a abundante, escassa e intermédia disponibilidade do recurso).

10. How much do you get during these three times (peak, low, in between) for the amount of work you do (not counting the time it takes to go to the resource area)
(e.g. two of us take all day to cut 12 bundles with a sickle
e.g. it takes me three hours to find one bucket of this food plant
e.g. one gill net set overnight catches 3 buckets of bream
e.g. fishing with a line for two hours catches 4 barbel.)
Descrevam o rendimento no trabalho durante os três períodos do ano (de abundância, de escassez e intermédia). Citaremos alguns exemplos para esclarecer a questão:
Exemplo 1: são necessárias 3 horas para conseguir um balde deste fruto silvestre
Exemplo 2: 2 usando foice, x pessoas precisam de um dia inteiro para cortar 12 molhos
Exemplo 3: pesca a anzol durante duas horas rende 4 peixes da espécie Y
Exemplo 4: o emalhe nocturno rende 3 baldes de peixe

11. How much can you sell this resource for locally? (get amount of money and units of resource sold clearly.Get a proper detailed description of the unit if necessary, e.g. 1 rabbit for MT 7000).
Por quanto é que vocês podem vender este recurso localmente? (Descrever quantidade em dinheiro e unidade de medida do recurso calaramente, por exemplo, 1 lebre por 7 000,00 MT)

12. If you can't get enough of this resource, what do you use instead? If it is used for several purposes, for example for thatching and to make baskets, do you use different substitutes for each purpose? Do you collect the substitute? If you buy it, how much does the substitute cost? (get amount of money and units of resource clearly).
Qual é o recurso alternativo que vocês usam quando não conseguem colectar quantidade suficiente deste? Quando o recurso que escasseia tem uma série de usos, vocês usam substitutos diferentes para cada propósito? O recurso alternativo é comprado ou colectado? Se é comprado, quanto é que custa? (dinheiro e unidade de medida descritos).

13. To everyone: can you recall changes in availabilty over the last 5 years? (This may be a combination of degradation and flood levels. Get them to quantify this with beans: put approximately equal quantities of beans in each square. Explain this is what no change looks like. If this is not true, then they can rearrange accordingly.)
Gostariamos que vocês descrevessem a variacão da disponibilidade dos recursos no últimos 5 anos (pode ser a combinacão da degradacão e do nível das cheias. Coloque quantidades aproximadas de feijões em várias áreas de uma folha de papel. Diga-lhes que isto corresponde às mudancas que ocorreram. Se eles não estiverem de acordo farão um rearranjo).

14. (Address this to the older members:) Has the availability of the resource increased or decreased over the last 20 or more years?. (Method as above.)
(Aos participantes mais velhos) Ocorreu mudanca na disponibilidade do recurso nos últimos 20 anos? (usar o método acima).

15. What are the causes of these long term changes?
Quais são as causas destas mudancas a longo termo?

16. If the trend is negative/problematic: What would you recommend as the solution?
Se as mudancas ocorridas são negativas e/ou problemáticas: Que solucões é que vocês recomendam?

16. We have discovered that people use XX______(no. of species) in this area. We would like to know how important it is to you to have XX ____. For example, if you could get the same amount of food from only YY _____ (<<XX), would it matter to you if the other ZZ (difference) were lost or no longer there? (prompt short discussion and record comments)
Ficamos a saber que as pessoas usam X_________ (número de especies). Qual é a importância que a obtencão de X________ tem para vocês? Vocês se importariam de, no lugar de colectar X______, colectar Y_____(outro recurso)?
Registar comentários e encorajar uma discussão sobre possibilidades de fazer menor pressão sobre um determinado recurso através do uso de outro em simultâneo, ou através do uso de recurso alternativo.

APPENDIX 4. SUMMARY OF EXISTING POLICIES IN FOUR ZBWCRUP COUNTRIES

Table 1: Existing policy instruments, goals and strategies in Zambia

Sector	Main instruments	Main policy goals and strategies
Macro-economic		Achieve sustained economic growth, reduced inflation and strengthened gross official reserves, by: Continued reduction in public sector Continued privatisation of non-mining public enterprises Improved regulation and supervision of large banks (large loan exposure, insider lending, provisioning) Reduce fiscal deficit while generating domestic budget surpluses Expansion of private sector activity Reducing public sector expenditure Strengthening tax base and administration Anti-inflationary measures Continuing trade and exchange rate liberalisation Continuing liberalisation of import tariffs Export promotion, especially with private sector participation
Environment	Environmental Support Programme Environmental Protection and Pollution Control Act 1990 Natural Resources Conservation Act 1970 Draft Wetlands Policy 1999 National Environmental Action Plan 1994	Promote sound natural resource management and environmental protection by: Strengthen institutional and regulatory framework for environmental protection and natural resources management Enable communities to address natural resource degradation Launch of Community Environmental Management Programme and Environmental Fund
Tourism	National Tourism Policy 1994	Develop a market-oriented private sector industry sensitive to community needs Create an economically and environmentally sustainable sector Ensure the preservation of environmental and cultural integrity
Forestry and wildlife	Wildlife Act 1998 Wildlife Policy 1993 Draft National Forest Policy 1998	Maximise and distribute equitably the sustainable value of forests and wildlife for the benefit of the resource and the people of Zambia, by: Maintaining forests and wildlife on private and communal lands Benefiting local communities, and engaging them in resource management Promoting private sector investment and management Rationalisation of pricing Inter and intra-sectoral co-ordination Conservation outside protected areas

		Biodiversity conservation Commercial utilisation and production
Fisheries	Fisheries Act 1974	Develop commercial fisheries, increase catches and develop aquaculture for the purposes of national food security, rural income, employment and export earnings., by: Expansion of fisheries area and catch Registration of fishermen and boats Control of fisheries gear, methods and areas
Agriculture	Agricultural Lands Act 1960 Agricultural Sector Investment Plan 1998	Promote more efficient smallholder production, with a view to increasing agricultural output and stimulating non-traditional exports, by: Improving smallholder access to inputs and financial markets (promotion of private sector in input distribution and agricultural marketing) Decentralisation of adaptive research and extension services Improving infrastructure Liberalisation of input and output markets and prices Removal of restrictions on domestic and international trade Expansion of rural finance
Land	Land Act 1995 Agricultural Lands Act 1960	Encourage equitable land allocation and sustainable land use through: Decentralising land allocation Improving land tenure, especially in communal lands Recognition and continuation of customary land tenure, and its conversion into leasehold
Water, sewerage and sanitation	National Water Strategy National Water Policy 1994 Water Supply and Sanitation Act 1997	Improve the access of urban and rural populations to clean water and sanitation, by: Strengthening urban water management Rehabilitating urban water supply and sewerage treatment facilities Increasing water fees and improving fee collection
Energy	Energy Policy 1995	Promote optimum supply and utilisation of energy, especially indigenous forms, to facilitate the socio-economic development of the country and maintenance of a safe and healthy environment: Increased private sector participation in power generation and supply Expansion of hydro-power Improvement of rural electrification Rationalisation of public utility prices Removal of restrictions on oil imports Maintain liberalised system of oil retail distribution and pricing
Industry	Investment Act 1991	Promote efficiency in the manufacturing sector, by: Export promotion & attracting foreign investment Private sector investment and development Divestiture of public sector enterprises

Table 2: Existing policy instruments, goals and strategies in Namibia

Sector	Main instruments	Main policy goals and strategies
Macro-economic	National Development Plan	To alleviate social and economic inequities through a programme of sustained economic growth, including: Liberalisation of prices and markets Strengthening of the tax administration Fiscal reforms Public expenditure cuts Restructuring of public enterprises Development and diversification of export base Increased role of private sector
Environment	12 Point Plan for Integrated and Sustainable Environmental Management 1993 Draft Environmental Management Act 1998	Promote sustainable development, protect biotic diversity, maintain ecological life-support functions, by: Democratising environmental management Environmental education and awareness Training and capacity building in environmental management Co-ordination of land-use planning Environmental impact assessment requirements Environmental standards and enforcement of penalties for offences Co-ordination of sectoral activities Habitat protection
Tourism	White paper on Tourism 1994	Promote re-investment of benefits into tourism sector and environment Encourage local community involvement and benefit sharing Co-ordinate private and public sector goals Ensure sustainable utilisation and development Provide incentives for private sector entry into the industry
Forestry and wildlife	Policy Document on the Conservation of Biotic Diversity and Habitat Protection 1994 Policy Document on Wildlife Management, Utilisation and Tourism in Communal Areas 1995 National Forestry Policy 1992	Management of forest and wildlife estate for ecological and environmental protection and economic gain, by: Sustainable and economic utilisation of resources Involvement of communities in management and use of resources Habitat protection Targeted and applied research Promotion of natural resource enterprises and wildlife conservancies Cross-sectoral co-ordination
Agriculture	Agricultural Policy 1995	Promotion of food self-sufficiency, income, employment and external trade, through: Concentrating resources on grain and beef production Liberalisation of agricultural markets and prices Integration of communal farmers into domestic and export markets Increased private sector participation in production and marketing Sustainable land and natural resource management
Land	Policy Document on Land Use Planning	To provide adequate land for the landless and to promote, facilitate and co-ordinate access to land to support long-term

	1994 Draft Agricultural (Communal) Land Reform Bill 1997	sustainable economic development, by: Land reform and improved and administration to reduce unjust land allocation Creation of integrated land-use planning capacity and requirements Regulation and regularisation of land tenure in communal areas
Water, sewerage and sanitation	Water Act 1995 Water Supply and Sanitation Policy 1993	The expansion and development of water supplies for domestic, mining and agricultural use, by: Economic pricing of water and full cost-recovery in water provision Prioritising water for human consumption Restructuring and decentralising water institutions

Table 3: Existing policy instruments, goals and strategies in Malawi

Sector	Main instruments	Main policy goals and strategies
Macro-economic		Restoration of macroeconomic and financial stability and alleviation of poverty, by: Redirection of public spending to priority sectors of health, education, agriculture Civil service reform Privatisation of state-owned financial and non-financial enterprises Price and market liberalisation, especially in agricultural and financial sectors Exchange rate liberalisation and depreciation External trade liberalisation, lowering of import tariffs, abolition of export and import licences Controlled public expenditure Inflation management Fiscal reforms, including decreased subsidies, strengthened tax administration
Environment	National Environmental Action Plan 1994 Environmental Management Act 1996 EIA Regulations 1997 Environmental Management Policy 1994	Ensure efficient resource utilisation by: Implementation of EIA regulations Adoption of policies for community natural resource benefit-sharing More strictly enforce estate conservation and afforestation covenants Strengthen regulation of industrial pollution Continued support for public and community investment in environmental issues
Tourism	National Tourism Policy 1994	Optimise tourism contribution to national income, employment and foreign earnings Create favourable environment for private sector entry into the industry Encourage community participation and benefits sharing Ensure the protection of natural and cultural heritage
Forestry and wildlife	Draft National Wildlife Policy 1997 Draft Forestry Policy	Maintain the integrity of wildlife and forests both within and outside protected areas, for biodiversity conservation and economic development, by: Sustainable utilisation Equitable access to benefits Protection of major ecosystems Promotion of economic value of resources Enhancing public awareness Promotion of co-operation with communities, NGOs and private sector
Fisheries	Fisheries Act 1966	Development of commercial fisheries, expansion of fishing area, increase catches and develop aquaculture for the purposes of national food security, rural income, employment and export earnings.
Agriculture	Agricultural and Livestock Development Strategy and Action Plan 1995 Draft Irrigation Policy and Development Strategy 1997	Strengthen food security, export earnings, income and employment, structural reform of sector, by: Crop diversification Commercialisation and privatisation of production and marketing Liberalisation of input and output markets and prices Stimulation of fertiliser use Privatisation of credit agencies

		Promotion of soil fertility initiatives (dissemination of legume seeds, improvement of land husbandry)
Land	Presidential Commission of Enquiry on Land Policy Reform	Reduce rural poverty, by: Land reform in agricultural sector Improve efficiency of land allocation and develop land markets
Water, sewerage and sanitation	Water Resource Act 1972	Expand service and strengthen financial viability, improve water supply management, encourage private sector participation and improve household access to clean water. by: Rehabilitation and construction of groundwater basal systems Protection of dams and reservoirs Decentralisation and increased community-based management of rural water Increased role of private sector in rural water provision Decentralisation of urban water through formation of regional water boards Maintain economic pricing of water (establishment of appropriate water tariffs)
Energy	Electricity Act 1998	Improve energy provision and efficiency by: Initiating private investment in energy sector Improving competition in electricity sector Price rationalisation Expansion of alternative energy sources (including interconnection with Cahora Bassa)
Industry		Privatisation and divestiture of state assets

Table 4: Existing policy instruments, goals and strategies in Mozambique

Sector	Main instruments	Main policy goals and strategies
Macro-economic		Strengthen foundations for economic growth, lower inflation, improved delivery of social services and poverty alleviation, by: Maintaining financial discipline Liberalisation of trade and investment Stabilisation of inflation Reform of civil service Privatisation and restructuring of state enterprises and banks Increase of private sector participation and competition in transport, energy and water sectors Reduction in tax distortions (lowering of corporate and personal income tax rates, VAT and more limited excise taxes introduced, reduction in import tariffs and import tax exemptions) Improvements in tax and customs administration, broadening of tax base Removal of all minimum agricultural producer prices Reduction in direct instruments of monetary control Introduction of money market and interbank foreign exchange market
Environment	Environmental Law 1997	Promote sustainable use of natural resources, by: Adoption of regulations for waste management, environmental management and marine pollution Establishment of environmental assessment review system Establishment and maintenance of protected areas Cross-sectoral integration
Tourism	National Tourism Policy 1995	Promote protection of strategic tourism areas Prioritise sector as vital for national reconstruction and development
Forestry and wildlife	Forestry Act 1965 Wildlife Act 1978 Policy and Strategy of Department of Forestry and Wildlife	Conservation, utilisation and development of forest and wildlife resources for the ecological, social and economic benefits of present and future generations, by: Community-based natural resource management Use of forest and wildlife resources for the alleviation of poverty Maintaining ecological integrity Promote the role of natural resources in economic development Rehabilitation and management of forests and wildlife for conservation of biodiversity Identification and delineation of protected areas Introduce participatory land use planning system Encourage private sector involvement
Fisheries	Fisheries Act 1990 Fisheries Policy and Implementation Strategy 1996	Maximise fisheries benefits while ensuring the sustainability of the resource, by: Promoting development through the optimal and rational use of resources Promoting small-scale fisheries Promote aquaculture Regulation of recreational fishing

		Regulating fishing techniques and areas
Agriculture	Agricultural Policy 1995	Develop agricultural activity so as to achieve food security, promote exports and sustainably utilise natural resource, through: Product diversification Improving market incentives, road infrastructure and the delivery of agricultural services Removal of impediments to the development of input markets
Land	Land Law 1997 Land Policy 1995	Adopt and enforce land tenure regulations, improve smallholder land tenure security, by: Decentralisation of land administration Divestiture of state landholdings and farms Reformation of land tax system Recognition of customary land tenure Compensation for communities who release land to outsiders as concessions
Water, sewerage and sanitation	Water Policy 1995 Draft water sanitation and hygiene strategy	Facilitation of the access of businesses and households to water, by: Increasing private sector participation Improved regulation and financial planning Establishment of regulatory board for water Rationalised water tariffs Improved cost-recovery, community and private sector participation in rural water provision Development of water resource management strategy Development of strategy for internationally-shared river basins Develop and implement riparian co-operative legal and institutional frameworks
Energy	Draft energy strategy Electricity Law 1997	Facilitate access of businesses and households to energy, by: Increasing private sector participation Increasing exports Promotion of competition in generation and distribution of energy Creation of decentralised electricity markets Improving access to electricity Increasing utilisation forms of energy more in relation to woodfuels Increasing the efficiency of biomass energy utilisation