Economic Analysis of Sustainable Natural Resource Use in Malawi

Economic Study

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The opinions expressed in this report are those of the authors and do not necessarily represent the views of the MoDPC or the UNEP.

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2. Elephants at Liwonde National Park, downloaded from www.ilovemalawi.blogspot.com on 29 January 2011.
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Acronyms and Abbreviations

AD	avoided deforestation
ADB	African Development Bank
ADD	Agricultural Development Programme
ADP	Agricultural Development Programme
AER	Annual Economic Report
AFSP	Agro-forestry Food Security Project
AIDS	Acquired immunodeficiency syndrome
ANS	Adjusted Net Savings
BEST	Biomass Energy Strategy
CA	Conservation Agriculture
CAADP	Comprehensive African Agricultural Development Programme
CBA	Cost benefit analysis
CCA	Community Conservation Area
CF	Conservation farming
CGE	Computable General Equilibrium
CIDA	Canadian International Development Agency
CITIES	Conservation in International Trade in Endangered Species
COMESA	Common Market for Eastern and Southern Africa
COOPI	Cooperazione Internationale
COUE	Cost of Unserved Energy
COURU	Cost of Unsustainable Resource Use
COVAMS	Community Vitalisation and Afforestation in the Middle Shire
CPI	Consumer Price Index
CRSP	Chambo Restoration Strategic Plan
DNPW	Department of National Parks and Wildlife
EFSDSRL	Enhancing Food Security and Developing Sustainable Rural Livelihoods
ESCOM	Electricity Supply Corporation of Malawi
EU	European Union
FAO	Food and Agriculture Organisation
FEU	Fishing Economic Units
FOREP	Forestry Replanting and Tree Nursery Project
FOSA	Forestry Outlook Studies for Africa

FRIM	Forestry Research Institute of Malawi
GCM	Global Circulation Models
GDP	Gross Domestic Product
GNI	Gross National Investment
GoM	Government of Malawi
GPS	Geographical Positioning System
GTZ	Germany Development Agency
HIPC	Highly Indebted Poor Country
HIV	Human immunodeficiency virus
IAA	Integrated aquaculture-agriculture
ICEIDA	Icelandic International Development Agency
IFDC	International Fertilizer Development Corporation
IFFNT	Innovative Fish Farmers Network Trust
IFMSLP	Improved Forest Management for Sustainable Livelihoods Programme
IFPRI	International Food Policy Research Institute
IGPWP	Income Generating Public Works Programme
IHS	Integrated Household Survey
IRLADP	Irrigation, Rural Livelihoods and Development Project
IRR	Internal Rate of Return
IUNC	International Union for Conservation of Nature
JICA	Japanese International Cooperation Agency
L&LS	Land and Lake Safaris
LM	Lake Malawi
LRCD	Land Resources Conservation Department
MALDECO	Malawi Development Corporation
MALEZA	Malawi Entrepreneur Zone Association
MCC	Millennium Challenge Corporation
MDG	Millennium Development Goal
MEMP	Malawi Environmental Monitoring Programme
MEPD	Ministry of Economic Planning and Development
MGDS	Malawi Growth and Development Strategy
MGDS	Malawi Growth and Development Strategy
MK	Malawi kwacha
MoALD	Ministry of Agriculture and Livestock Development
MoDPC	Ministry of Development Planning and Cooperation

MPEI	Malawi Poverty and Environment Initiative
MRFC	Malawi Rural Finance Company
NAC	National Aids Commission
NAPA	National Adaptation Programmes of Action
NASP	National Aquaculture Strategic Plan
NEAP	National Environmental Action Plan
NEPAD	New Economic Partnership for African Development
NFP	National Forestry Programme
NGO	Non-Governmental Organisation
NPV	Net Present Value
NR	Natural Resource
NRCM	National Research Council of Malawi
NRM	Natural resource management
NSO	National Statistical Office
NTFP	Non-Timber Forest Products
NWDP	National Water Development Project
NWFP	Non-Wood Forestry Products
ORT	Other Recurrent Transactions
PAPPA	Poverty Alleviation Pilot Project and Agroforestry
PFM	Participatory Fisheries Management
PIAD	Presidential Initiative on Aquaculture Development
PM	Particulate Matter
PROSCARP	Promotion of Soil Conservation and Rural Production
REDD	Reduced Emissions from Deforestation and Forest Degradation
SACCO	Savings and Credit Cooperatives Organisation
SLEMSA	Soil Loss Estimation Model for Southern Africa
SLM	Sustainable Land Management
TCA	Transfrontier Conservation Area
TLC	Total Land Care
TPMCSOES	Tree Planting and Management for Carbon Sequestration and Other Ecosystem Services
UN	United Nations
UNCCD	United Nations Convention for Combating Desertification
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme

UNFCCC	United Nations Framework Convention on Climate Chance
US$	United Stated dollar
USAID	United States of America International Development
WB	World Bank
WCMC	World Conservation Management Centre
WESM	Wildlife and Environmental Society of Malawi
WHO	World Health Organisation
WTTC	World Travel and Tourism Council

Executive Summary

A. Background

Malawi is a small land-locked country located in southern-central Africa, bordered by Tanzania to the north, Zambia to the west and Mozambique to the east and south. According to the World Bank[1], the country's GDP was estimated at US$3.5 billion in 2007, equivalent to per capita income of about US$250. Some 40% of the country population of 13.1 million was categorized as poor in 2008. (NSO, 2009). Malawi ranked 160th out of 182 countries in the United Nations Development Programme's (UNDP's) Human Development Index for 2009 (UNDP, 2010).

The environment plays a very significant role in influencing social and economic development at both the household and national levels. Approximately 80% of Malawians depend on renewable natural resources for their subsistence and household income, and the foundation of the national economy is primarily rain-fed agriculture.

B. Study Objectives

The Government of Malawi (GoM) is implementing the Malawi Poverty and Environment Initiative (MPEI) with support from the Global Poverty and Environment Initiative of the United Nations Development Programme (UNDP) and the United Nations Environmental Programme (UNEP). MPEI's broad aim is to enhance the contribution of the sustainable management of natural resources (NR) to poverty reduction, food security and economic growth, and to facilitate the achievement of both the Malawi Growth and Development Strategy (MGDS) and the Millennium Development Goals (MDGs). The study was conducted in 2008 and the 2007 prices were used.

This Economic Study is conducted within the context of the MPEI project. The primary aim of the study is to provide evidence on the costs and benefits of sustainable and unsustainable natural resource management (NRM) in Malawi, for four selected natural resources: forestry resources, fisheries resources, wildlife resources and soils. The analysis establishes linkages between natural resource management on the one hand, and poverty reduction, economic well-being and development on the other. Further, we draw on case study and other evidence to assess the net benefits of key interventions to encourage more sustainable natural resource use in each selected NR sector.

C. Key Observations

C1. Valuing the Macro-Economic Contribution of Natural Resources

The economic contribution made by renewable natural resources to Malawi is very significant but is not adequately captured in official statistics. Part of the problem lies with how national income is measured – estimates of Gross Domestic Product (GDP) do not record the contribution of soils or wildlife. Even where natural resource use is recorded in GDP (as with forestry and fisheries) the values tend to be understated. For example official GDP figures in Malawi significantly understate the true contribution of forestry by not capturing the extensive use of wood for fuel.

In this study these valuation issues were addressed as follows:

[1] http//data.worldbank.org/indicator

1. Making use of detailed recently published studies of the forestry and tourism resources in Malawi, we produced revised estimates of GDP contributions by natural resources.

2. Using primary research undertaken in this project as well as existing data, we identified the economic cost of soil degradation on agriculture and the impact on hydro-electric power production, as well as net loss of forest resources and costs of air pollution in Malawi. The economic cost of unsustainable fishing was estimated by comparing the returns of more and less sustainable fishing practices. Indicative costs of wildlife poaching were extrapolated from a detailed study of two protected wildlife resources.

3. Finally, we calculated Adjusted Net Savings (ANS) for Malawi – a measure of national wealth that incorporates natural resource use.

C2. Contribution of Renewable Natural Resources to GDP

Table i below summarises the contribution of forestry, fisheries and wildlife resources to GDP in official statistics and estimates using recently published specialist studies.

Table i: Contribution of Natural Resources to GDP

Natural Resource	*Share of GDP by Official Statistics*	*Additional contribution identified*	*Total share of GDP*	*Sources of new evidence*
Forestry	1.8%	4.3%	6.1%	**BEST (2009) – charcoal & firewood**
Fisheries	4.0%	-	4.0%	
Wildlife	-	2.7%	2.7%	**WTTC (2009) – nature-based tourism**
Total	**5.8%**	**7.0%**	**12.8%**	

Even viewed through the narrow prism of GDP statistics, the contribution of renewable natural resources is striking. The large contribution of charcoal and firewood is omitted in official statistics. In contrast, the contribution of the tourism and travel industry is included but the key role of wildlife (and the ecosystems that support this) is not quantified. By analysing the constituent elements of the travel and tourism satellite accounts for Malawi prepared by the World Travel and Tourism Council – WTTC (2009) – we concluded that nature-based tourism contributed around 2.7% of total GDP. Thus, roughly half of Malawi's total travel and tourism receipts were accounted for by overseas visitors undertaking nature-based tourism.

C3. The Macro-Economic Cost of Unsustainable Natural Resource use

Table ii summarises our base case estimates of the cost of unsustainable natural resource use and the source of these costs for each natural resource. The calculations are summarised below, but their details can be found in the chapters on the relevant natural resources.

Malawi pays a high price for unsustainable natural resource use. This cost is equivalent to giving up 5.3% of GDP each year. To put this in context, the MGDS aims for *total* annual GDP growth of 6%. Malawi would be richer by MK 26.6 billion (US$191 million) each year in 2007 prices if soil, forest, fishery and wildlife resources were used sustainably. This is more than the total funding allocated to the education sector and to the heath sector in the 2009 Budget.

With a 10% discount rate, the discounted value of unsustainable natural resource use over a decade amounts to more than MK84 billion (US$600 million) in 2007 prices – about MK 28,000 (US$200) for each household in Malawi.

Table ii: Economic Costs of Unsustainable Natural Resource use

Natural Resource & source of cost – base case	*Annual cost (2007 prices)*			*Discounted cost of damage over 10 years*	
	MK Million	*US$ Million*	*% of GDP*	*MK Million*	*% of GDP*
Soils:	**8,988**	**65**	**1.9%**	**40,665**	**8.2%**
On-site impact on agriculture	7,540	54	1.6%	30,915	**6.3%**
Off-site impact on hydropower	1,433	10	0.3%	9,688	**1.9%**
Off-site drinking water treatment	15	0	0.0%	62	**0.0%**
Forests:	**12,983**	**93**	**2.4%**	**31,795**	**11.0%**
Unsustainable roundwood (excl fuelwood)	3,100	22	0.4%	12,710	**2.4%**
Unsustainable fuelwood	6,089	44	1.2%	2,495	**4.8%**
Flood prevention (indicative only)	232	2	0.2%	1,987	**0.8%**
Indoor air pollution	3267	23	0.7%	13,394	**2.7%**
Outdoor air pollution - WB 2002	**327**	**2**	**0.2%**	**2,417**	**0.5%**
Fisheries:	**3,906**	**28**	**0.8%**	**7,666**	**1.5%**
Unsustainable use (lower bound)	3,906	28	0.8%	7,666	**1.5%**
Wildlife:	**665**	**5**	**0.1%**	**2,730**	**0.5%**
Poaching loss (indicative only)	665	5	0.1%	2,730	**0.5%**
Total	**26,573**	**191**	**5.3%**	**84,064**	**21.4%**

The largest costs result from the loss of agricultural productivity as a result of soil degradation, deforestation in catchments around the main urban centres to supply firewood and charcoal, unsustainable fishing and reduced economic activity caused by indoor air pollution.

There is compelling evidence that unsustainable natural resource management leads to increased poverty in Malawi. For instance, World Bank data from 1992 indicated average annual agricultural yield loss of 4% – 11% as a result of soil erosion, while Bishop (1995) estimated mean annual yield losses of 8% – 25%. To relate, Benin *et al* (2008) forecast that achieving 6% growth in agricultural yields during 2005-2015, would increase overall GDP growth by 3.2% - 4.8% per year, leading to the proportion in poverty falling to 34.5% by 2015, which is considerably lower than the 47.0% poverty rate projected in the absence of the additional agricultural growth. The 6% agricultural yield growth results in an additional 1.88 million people being lifted above the poverty line by 2015.

Moreover, if *all* the lost economic value from unsustainable resource use each year in Table ii (5.3%) was converted into economic growth, the impact on poverty would be much larger. The potential magnitude of this impact can be seen by considering the MDG1 scenario modelled by Benin *et al* (2008). In this case, GDP growth is 4.2% per annum above the baseline case (7.4% rather than 3.2% yearly). If this had been done over the period 2004 – 2015, the proportion in poverty would be halved from its 1990 level – to 25.2%. Clearly this is no longer achievable by 2015 but it serves to illustrate the enormous potential for poverty reduction that more sustainable natural resource use could have.

C4. Unsustainable Natural Resource Use and Adjusted Net Savings

If forest, fisheries and soil nutrient resources are used up faster than they are replenished, Malawi is consuming her natural capital. ANS, sometimes known as genuine savings, is a green accounting measure that takes this measure of natural capital as well as health damaging air pollution into account, alongside the standard measures of physical and financial savings. Human capital formation (spending on education) is added as an investment in the ANS calculation so that, overall, it provides a holistic measure of national wealth.

The World Bank has estimated ANS for 2006 for Malawi as being 12.24% of Gross National Investment (GNI), indicating that national wealth is increasing. However, this estimate excludes the latest evidence on deforestation from woodfuel use, the cost of soil nutrient losses, estimates of the costs of indoor air pollution or any estimates for the fishery or wildlife resources. By including these items (from Table 1 deflated to 2006 prices) we find that the country's ANS for 2006 falls to 7.14% of GNI (see Table iii). What is particularly troubling is that the contribution to national wealth from educating the nation is outweighed by the loss of wealth from natural resources degradation.

Table iii: Adjusted Net Savings for Malawi

	WB (2006)	*WB+Authors*
	% of GNI	*% of GNI*
Gross National Saving (various methods used)	15.69	15.69
- Consumption of Fixed Capital	7.30	7.30
= Net National Saving	8.39	8.39
- Education Expenditure	4.87	4.87
- Energy Depletion	0.00	0.00
- Mineral Depletion	0.00	0.00
- Net Forest Depletion	0.64	2.05
- Soil Erosion		2.01
- Fishery depletion (lower bound)		0.87
- Wildlife depletion (indicative)		0.15
- CO_2 damage	0.22	0.22
- PM10 damage (Outdoor air pollution WB 2002)	0.16	0.16
- Indoor air pollution		0.66
= Adjusted Net Saving	12.24	7.14

C5. Forestry Resources

Forestry resources are crucial in supporting livelihoods, infrastructure development and energy in Malawi. Apart from providing a diverse range of wood and non-wood products, forests are important for soil and water conservation for agriculture and household use, for provision of animal habitat, for beautification of the countryside, for enhancement of ecotourism, and for regulation of climate change. Little of this contribution is captured in GDP estimates and the officially reported contribution of the sub-sector to national output, at 1.8%, is certainly an understatement. The 2009 Malawi BEST study estimates that wood fuel accounts for an additional 4.3% of annual GDP. Full-time employment in forestry is around 29,000 with a further 130,000 full-time jobs involved in wood fuel supply.

Royalties levied on forest products by Government amount to some MK 163 million (US$1.17 million) annually, well below resource rents, because the rates do not reflect current market prices and collection of royalties and fees is limited, in part, by inadequate funding. Records suggest that the sub-sector currently only receives about one-fifth of its desired operating budget per annum, estimated at about MK250 million (US$1.79 million).

Firewood is immensely important for household energy (providing 95% of rural household energy supply and 55% for urban households), with charcoal providing around a third of urban household energy supply. While forests are also an important source of various non-wood products (such as mushrooms, bush meat, fruits, juices, honey, fodder and thatching grass), most of these are produced and used in the informal sector, and reliable estimates of quantities produced and their values are unavailable.

Evidence suggests that forestry resources are degrading at a fast rate – officially at 2.6% per annum, but case studies generated for this study estimate annual deforestation at between 0.67% for the Linthipe catchment and 2.12% for the Lower Shire catchment. The principal cause is agricultural expansion driven by population growth. However, forest degradation for fuel wood (firewood and charcoal) is a significant problem in the catchments surrounding Lilongwe, Blantyre, Limbe and Zomba.

We estimated the main costs of unsustainable use of forest resources in this study. Using World Bank data for roundwood, excluding wood used for fuel, we found that the removal of roundwood faster than it grows costs MK 3.1 billion (US$21.2 million) each year. The additional annual economic costs of excess roundwood use for firewood and charcoal in the major urban catchments were estimated at MK6.1 billion (US$42 million). Forests are likely to have a role in flood prevention but the science in this area is contested. We estimated that flood-related economic costs as a result of deforestation lie in the range US$0 – US$1.0 million per year. There is consensus on the health impacts of indoor air pollution from burning firewood and charcoal but the value placed on increased morbidity and mortality is open to discussion. We therefore estimated alternative scenarios for indoor air pollution costs but in the base case the annual cost was found to be MK 3.3 billion (US$23.5 million).

Evidence from the literature reviewed and our case studies indicates the critical importance of tackling deforestation and forest degradation resulting from excess demand for wood fuel resources around the major urban areas. Possible interventions can be suggested, as follows:

Intervention 1 - Increasing the supply of woodfuel. The forestry component of the EU-funded Income Generating Public Works Programme (IGPWP) is particularly interesting as an intervention, as it aims to reduce poverty by increasing local production of fuelwood, timber and poles through planting community (forestry club) woodlots and planting on individual club member farms. After a successful three-year first phase, the programme has now entered a second phase with the target of planting 35,500,000 trees over a 5 year period. Using data from the IGPWP we estimated that with payments per project club member of around MK 1500 (US$10) over two years (as incentives to raise seedlings and ensure the survival of trees planted out) the average club member plants 858 trees. After growing for 5 years this number of trees can supply a family of five with 2.5 years of fuelwood and as these trees coppice we can say the families involved will gain around 50% of their total fuelwood requirement for the rest of their lives.

Our detailed economic cost benefit analysis (CBA) for phase 1 of the IGPWP incorporated project costs, costs of farmers' labour, private benefits (wood supply to those growing trees), and social benefits (primarily carbon sequestration but also modest contributions to reduced hydro-electric generation losses, reduced drinking water treatment costs and flood prevention). The economic CBA finds this project has an internal rate of return (IRR) of 62% - based on farmers continuing to coppice trees in subsequent five-year periods where no incentive payments are made. Hence, the analysis supports use of public funds to replicate this project in catchments facing pressures of deforestation.

While this project intervention is a good use of public funds, it may not be financially attractive from the farmer's perspective. Hence, we also undertook a financial CBA from the farmer's point of view with benefits defined narrowly (wood sales or time savings) or more broadly as including wood sales and payment for environmental services. We concluded that:

1. Tree planting schemes that relied **only** on the financial returns from poles or time savings from producing wood fuel might not be sufficiently attractive to get widespread uptake.
2. Adding carbon payments would make things a lot more attractive from the farmer's perspective. While our figures on expected carbon payments were only indicative, they suggested that regular annual payments might not be enough to encourage risk-averse farmers to invest in tree planting. In this situation it would be necessary to make larger payments in the early years. By raising carbon payments by 50% in the first three years and compensating with a 10% reduction in years 4 – 20, the total payment was slightly reduced but it became very attractive to even those farmers with high discount rates.
3. The IGPWP approach of providing incentive payments (of around US$6/club member) in each of the first two years would succeed in making investing in tree planting financially attractive to poor farmers with very high discount rates.

Intervention 2 - Options and payments for more sustainable charcoal production. Urbanisation and growing real incomes are likely to cause the demand for charcoal in Malawi to double in the next 15 years. Therefore, any successful strategy for tackling deforestation will have to address how to produce and market charcoal from sustainably grown wood. The current policy of banning charcoal production has not only proved ineffective but encourages inefficient illicit charcoaling, produces incentives for corruption and deprives the GoM of tax revenue. Our economic analysis of published data indicates that the annual estimated value of bribes paid on charcoal in 2008 was MK 1.3 billion (US$9 million). Transferring these payments from the informal sector to formal taxes would produce revenue for environmental protection or other pro-poor expenditure.

Interventions to strengthen policy and institutional capacity building are likely to be the most urgent in this area, but economic analysis revealed that:

- The total *potential* value of annual carbon payments for charcoal produced was approximately MK2.5 billion (US$16.8 million).
- A holistic solution that would address the whole charcoal supply chain was needed, rather than a technical fix in any one area. So, for example, improved charcoal kilns could play a useful role in reducing the 2.25 million cubic metre excess demand for fuelwood in urban catchment areas but, by themselves, would provide less than 15% of this excess demand.
- Subsidising electricity consumption would not solve the charcoal problem given that increasing the rate of domestic electrification would imply switching supply from industrial and commercial sectors. Moreover, those with an electricity connection would make

significant savings compared to those relying on charcoal or purchased fuelwood. Based on an average domestic consumption of 3,285 kwh and a current tariff of US$0.043/kwh substituting 883 kg of charcoal and 30 litres of paraffin would save the electrified urban consumer around US$105 a year. Even at full cost tariffs (0.065/kwh) urban consumers would save around US$60 year.

C6. Fisheries Resources

Fisheries resources contribute to the livelihoods of more than 1.6 million Malawians. Almost 60,000 individuals are employed as fishers, and about 450,000 are engaged in fisheries-related economic activities. However, these and many other official figures on fisheries have not been revised for some time, reflecting the data gaps that exist in the sub-sector, as in all natural resources.

The landed value of fish was MK9.4 billion (US$67.1 million) in 2008, a significant contribution to the economy's total output. Traditionally, fish has been the most affordable source of animal protein, but the real price of fish (after accounting for inflation) has increased by about 3.5 times over the period 1987 – 2007. Over the same period, the population of Malawi grew by about 61% from 7.9 million to about 12.7 million, while total fish supply has fallen by 20%. As a consequence, per capita fish consumption has fallen from 9.4 kg to 5.4 kg between 1990 and 2008. Population growth and overfishing (which are potentially closely related) are, arguably some of the key causes of declining per capita fish consumption.

The poor are least able to replace this lost source of protein. Rural households may switch to more costly and demanding alternatives in the form of keeping livestock. Those without this option have to spend an increasing proportion of their scarce income on substitutes, or make do without the protein. As around 66% of the population does not even consume the minimum calories required, it is very likely that these mainly rural people simply reduce their protein intake when faced with steep increases in real fish prices.

Between 1987/88 and 1995 the fisheries sub-sector experienced a sharp decline in production from natural waters but this trend experienced something of a reversal between 1998 and 2007. However, the experience has varied within segments of the fisheries industry. The artisanal catch in Lake Malawi had recovered fully by 2004 and now exceeds the 1987 level while the catch has declined over the period in all other types of fishing. While the output of cultured species, valued at US$ 1.4 million in 2008, has grown by 52% over the period 2000 - 2008, it still only contributes about 2% of total fish production and is very far from meeting the excess demand for fish.

The current study attempted to assess the economic implications of unsustainable fishing. Since bioeconomic models for each water body derived from scientific estimates of maximum sustainable yields were not available, we calculated indicative, lower bound estimates of the cost of unsustainable fishing based on the following:

- We calculated what the catch from each of the other water bodies as well as the Lake Malawi commercial fishery would have been **if** it had followed the same pattern as the Lake Malawi artisanal fishery. This implied restricting catches in the middle of the period so that later catches recover.

- We calculated the difference between actual and projected yields for each fishery, for each year to 2007. Note that this was negative for three years, as restraint lowered total catches. The annual difference was valued at 2007 prices. We calculated the discounted value of the additional catch over time (MK7.7 billion or US$55 million) and the 2007 value of this additional catch (MK3.9 billion, US$27 million). The latter figure was used for the lower bound estimate of lost annual fishery yield from unsustainable practices.

Overexploitation of shallow waters and a lack of investment in technologies suited for fishing in deeper waters have been documented as major problems experienced in the sub-sector. The complex nature of the sub-sector, involving multiple types of stakeholders, has also been cited as a fundamental challenge. Nonetheless, despite problems largely associated with poor funding and lack of human capacity in the Fisheries Department, there have been some successes in recent years.

An evaluation of the impact of development and dissemination of integrated aquaculture-agriculture (IAA) technologies in Malawi by Dey *et al* (2006) illustrates an interesting pro-poor intervention. With this intervention, existing resources (in the form of organic wastes and byproducts) from the farm are utilized as nutrient inputs in ponds. This WorldFish Centre project used an innovative "farmer participatory research" approach to technology transfer. In economic terms the project has been a success. Taking all the project costs into account, it is estimated to have produced a benefit-cost ratio of 1.4 with an internal rate of return of 15% over the period 1986 – 2001. It has also made financial sense for households adopting IAA as the returns to labour from aquaculture are higher than the returns obtained from supplementary off-farm work. This suggests that there is scope for further expansion of the IAA model in Malawi.

C7. Soil Resources

Malawi's soils are predominantly of three major types: the Eutric leptisols, the Chromic levisols and the Haplic lixisols of variable morphology, with localised areas of Acrisols, Cambisols, Gleysols, Phaezems, Planosols and Vertisols.

Over 80% of Malawians depend on agriculture as their main economic activity and a major source of livelihood, hence the country's topsoil remains an important natural resource. But this resource continues to be degraded at an accelerating speed. According to the National Environmental Action Plan (NEAP), soil erosion is caused by expansion of agriculture, deforestation, overgrazing, and land scarcity leading to people cultivating in marginal and fragile lands. The solutions to the problem of soil erosion are succinctly presented in the country's Agricultural Development Program (ADP) under Focus Area III.

Estimates of soil loss based on a limited number of sample sites indicate an average loss of approximately 20t/ha/year. Studies that have translated this into yield losses suggest a 4% - 25% loss each year. A conservative estimate is that the annual on-site loss of agricultural productivity as a result of soil degradation cost MK7.5 billion (US$54 million or 1.6% of GDP) in 2007. In addition, soil erosion negatively affects hydro-electric power generation. Using data from ESCOM and the Millennium Challenge Corporation (MCC) on the costs of minimising this impact, we estimated annual costs of some US$10 million in 2007 prices. We also identified small off-site impacts on drinking water treatment costs (approximately US$100,000 per annum) and impacts on the productivity of fisheries which we have not been able to quantify.

A number of interventions to promote soil conservation have been sponsored by Government, but perhaps the most significant government programme is the ADP under Focus Area III, which is aimed at increasing agricultural area under Sustainable Land Management (SLM) from 100,000 hectares to 250,000 hectares. We analysed some possible interventions, as follows:

*Intervention 1 - Contour ridging and planting of vetiver hedgerows***.** In the Middle Shire Case Study prepared by Mlava *et al* (2010), it is argued that the traditional contour ridging technology is what most farmers are using. This is where farmers plant on ridges 75-90 cm apart reconstructed every year; and weeding once and earthing up the ridge using a hoe. International experience and considerable experience within Malawi over the past 20 years suggests that contour marker ridges should be used to realign crop ridges to the contour on all cultivated land with slopes greater than 3% but less than 13%. Almost 54% of the Middle Shire catchment has such characteristics. Mlava *et al* (2010) argue that this would control runoff and erosion, and increase infiltration, particularly when used in combination with tied ridges. Vetiver (or other thick stemmed grasses) should be planted on contour markers and managed to form vetiver hedgerows which provide a barrier to runoff.

Analysis of PROSCARP Project costs showed a total annual cost for the same activities of MK6,356/ha (US$44/ha). However, once conservative estimates of farmer labour costs were included, total costs rose to approximately MK 11,000/ha in year 1 and MK 600/ha in subsequent years.

Benefits from these soil conservation interventions accrue off-site (e.g. reduced costs faced by hydroelectricity generators) and to farmers who introduce them. However, it can take some time for farmers to realise these benefits in terms of increased yields. In Section 6 we estimate that off-site hydroelectricity costs from soil erosion are MK 1,433 million (US$ 10 million) per year. As the Middle Shire catchment is the principal source of hydroelectric generation in Malawi (and the basis for our cost estimates), this cost is allocated to the area of farmland in the catchment. Remote sensing undertaken for this study indicates 689,300 ha of farmland in the Middle Shire. Hence if the soil conservation interventions are successful we can argue that they produce an off-site value of MK 2,079/ha (US$ 14.2/ha) in this catchment.

As noted above, the impact on agricultural yields is likely to build up over time. Unfortunately, at the time of writing we do not have estimates of soil and hence yield loss for the Middle Shire catchment. Using average figures for Malawi and assuming that this intervention reduces 20% of yield losses attributed to soil erosion in year 1 rising to 100% in year 5, we estimated on-site benefits rising from nearly MK 500/ha in year 1 to nearly MK 2,500/ha (US$17/ha) in year 5.

Over a 10 year period, the estimated economic internal rate of return to these interventions is 42%. As the discount rate for socially beneficial projects is often taken to be 3% the economic justification for this kind of soil conservation project is very strong. Even if there were **no** yield benefits to farmers, this project could be justified on economic grounds as the estimated IRR on the basis of off-site benefits alone is 16%.

Things look somewhat different from the farmer's perspective. Over a 10 year period, the estimated financial IRR is just below 10%, but the private discount rate of small farmers in Malawi is many times this level. A number of implications follow logically from these results:

1. Farmer's will not undertake these soil conservation interventions unless incentivised or compelled to do so.

2. As these interventions are clearly justified from a national (economic) perspective, government should consider paying farmers who provide this environmental service.

3. As the private discount rate of many farmers is likely to be higher than the social return to this intervention, paying what is worth to the Nation is probably not enough *by itself* to encourage most farmers to adopt soil conservation interventions. However, if soil conservation interventions can be combined with conservation agriculture to raise yields significantly in the short term the package as a whole is likely to change farmers' behaviour.

Intervention 2 - conservation agriculture. Minimum tillage combined with undersowing with Tephrosia vogelii has the potential to significantly increase maize yields and farm profitability if farmers apply fertilizer (and ideally herbicides). The mid-term review of the EFSDSRL Project concludes that "the activities with the best effect are beyond doubt the ones on conservation agriculture (CA), where the good demonstration effect has made some additional farmers adopting the techniques without support from the Project, buying input materials from own funds" (p19). Williams (2008) surveying farmers in the TLC Chia Lagoon Project finds that 98% of farmers trying CA were satisfied with the results.

Hayes, Bunderson and Jere (1999) report the results of two farmer field trials involving undersowing Tephrosia vogelii and maize. The first trial involved undersowing *Tephrosia* with maize in year 1 with normal ridging. Sowing involved 2 stations of *Tephrosia* between maize stations on every ridge at 3 seeds/station 2 cm deep. In year 2, *Tephrosia* was left as a fallow with no tillage. It was then cut down just before the onset of year 3. Leaf biomass was left on the soil surface and stems were removed for fuelwood. Thereafter, maize was cultivated under a system of reduced tillage with *Tephrosia* undersown again at the start of year 5 to repeat the cycle.

Their results show that over a five year period the discounted benefits (at a 50% discount rate) of undersowing maize with reduced tillage and fertilizer are more than 25 times the discounted costs. Provided farmers have access to fertilizer this intervention will be extremely financially attractive.

It is important to note that this cost-benefit analysis shows that undersowing with a fallow season is recommended only with fertilizer due to the loss of production in the fallow phase unless this land is not planned for cultivation. The reduced tillage practice common to conservation farming (CF) and CA also does involve significantly more labour input in the first year (particularly for weeding) unless herbicides are available. Although, as Haggblade and Tembo (2003) explain, dry-season land preparation, though arduous in early years, becomes easier over time and the redeployment of field preparation labor and draft power to the off-season relieves peak season labour bottlenecks, thus enabling early planting and weeding.

C8. Wildlife Resources

Tourism in Malawi is overwhelmingly nature-based, and it is one of the foreign exchange earners for the country. While in 2001 it generated 1.8% of the country's total GDP, this increased to 5.8% in 2007. This is a clear demonstration of its growing importance to the country's economy.

To date the key role of wildlife has not been quantified. We addressed this gap by analysing the constituent elements of the travel and tourism satellite accounts for Malawi prepared by the World

Travel and Tourism Council – WTTC (2009). These showed that, in 2007, nature-based tourism contributed 2.7% to GDP.

Case study data produced for this study revealed the huge asset values of Malawi's national parks, wildlife reserves and nature sanctuaries. Lengwe, one of the five national parks was calculated to hold a stock of wildlife valued at US$17.7 million (MK2. 5 billion) at current market prices for live animals. However, all the animal numbers were below the required maximum carrying capacity. Based on the park restocking plan and animal carrying capacities, the economic value of the animals in this one park would rise to approximately MK11.2 billion (US$80 million).

In order to estimate the cost of unsustainable use we would need to consider how the stock of animals changes rather than the total stock level. This, however, was constrained by the absence of data on population dynamics for the main species in each park/reserve. Of the many causes of net wildlife loss, poaching is considered to be the principal cause. We used detailed estimates of poaching losses over a number of years from two protected areas (Majete and Lengwe) to estimate indicative figures per square kilometre for all protected areas. On this basis, we estimated that the unsustainable use of wildlife resources costs MK665 Million (US$ 5 Million) each year.

C9 Cross-cutting Issues

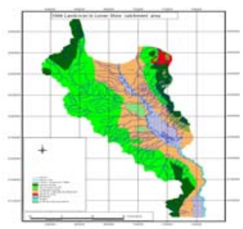
There is a need to improve coordination among stakeholders of various natural resources. These include Government Ministries and Departments, development partners and civil society organization.

There is also a need to have reliable data in the various sectors.

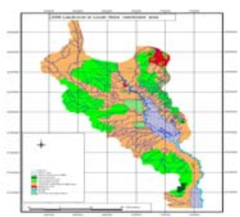
1. Introduction

A:Lower Shire Land Cover

1994



2008



B: Liwonde National Park

D: Soil Erosion in Malawi

C: Liwonde National Park

E: Malawi Chambo

A: From Mlava *et al* (2009)
B: From www.ilovemalawi.blogspot.com as at 27/01/11
C: From www.ilovemalawi.blogspot.com as at 27/01/11
D: From www.flickr.com/johndufell as at 27/01/11
E: From www.nationalgeographic.com as at 27/01/11

1.1 Background

Malawi is a small land-locked country located in southern-central Africa, bordered by Tanzania to the north, Zambia to the west and Mozambique to the east and south. Lake Malawi forms the eastern boundary for over one half of its length, and water accounts for 20% of the country's area ( ). With a population estimated at 13.1 million[2] in 2008 and growing at the rate of 2.6% per annum, Malawi has a population density of 1.45 people per ha. This ranks it fifth on the African continental mainland (Malawi BEST[3], 2009).

According to the World Bank[4], the country's GDP was estimated at US$3.5 billion in 2007, equivalent to per capita income of about US$250. In 2008, it was estimated that 40% of the country's population was poor, with 15% of them categorised as ultra poor. These figures show a significant improvement from those recorded in 2004, which were at 52% and 22%, respectively (GoM, NSO, 2009). Malawi ranked 160th out of 182 countries included in the United Nation Development Programme's (UNDP's) Human Development Index for 2009 (UNDP, 2010).

The environment plays a very significant role in influencing social and economic development at both the household and national levels. Approximately 80% of Malawians depend on renewable natural resources for their subsistence and household incomes, and the foundation of the national economy is primarily rain-fed agriculture. The sustainable management of natural resources - such as land, soil nutrients, forests, water, fisheries, wildlife and air - could contribute to enhanced growth and poverty reduction. However, evidence demonstrates that these resources are degrading at alarming rates on account of unsustainable use largely arising from high population growth rates, poverty, agricultural expansion, inappropriate management practices, low capacities for governmental enforcement of rules, and - especially in the past - weak policies.

[2] This is according to the 2008 Population and Housing Census. See www.nso.malawi.net.
[3] BEST stands for Biomass Energy Strategy.
4 www.ddp-ext.worldbank.org.

Figure 1: Map of Malawi

The Government of Malawi (GoM) formulated the Malawi Growth and Development Strategy (MGDS) as the overarching strategy for achieving economic growth and development over the period from 2006/07 to 2010/11. The MGDS sets out ambitious targets for economic growth and poverty reduction, including 7.0% annual growth in agriculture, in order to achieve food security and to enhance incomes, foreign exchange earnings and the general wellbeing of Malawians. The MGDS sets an economic growth target of above 6.0% per annum, and envisages that this would emanate from growth in agriculture, manufacturing, mining and services sectors. Malawi's real GDP has grown by an average of 7.8% per annum between 2006 and 2010 (Mangani, 2011). The unsustainable use of natural resources and their degradation will, however, make it increasingly hard to achieve the national development priorities. Climate change further threatens the attainment of the MGDS targets. In this regard, the MGDS includes conservation of the natural resource base as a sub-theme under Theme 1 of Sustainable Economic Growth. A revised version of the MGDS also highlights climate change, environment and natural resource management as one of the three new priority areas, bringing the total number of priority areas to nine. This reflects Government's commitment in combating natural resources degradation and securing environmental sustainability, in keeping with Goal 7 of the United Nations' Millennium Development Goals (MDGs).

In order to complement these efforts, the government is implementing the Malawi Poverty and Environment Initiative (MPEI) with support from the United Nations Development Programme (UNDP) and the United Nations Environmental Programme (UNEP). MPEI is part of the UNDP-UNEP Global Poverty and Environment Initiative. Its broad aim is to enhance the contribution of the sustainable management of natural resources to poverty reduction, sustainable economic growth and food security, and to facilitate the accomplishment of both the MGDS and the MDGs. This Economic Study is conducted within the context of the MPEI project, in order to support evidence-based policy-making and resource allocation processes affecting the natural resources sector in Malawi.

1.2 Objectives of the Economic Study

The primary aim of the Economic Study is to generate and provide evidence on the costs and benefits of sustainable and unsustainable natural resource management. Overall, the analysis also establishes linkages between natural resource management on the one hand, and poverty reduction, economic well-being and development on the other. The ultimate objective of the study is to sensitise decision-makers on the importance of taking environmental sustainability into account in the process of policy formulation and investment decision-making.

This report is a consolidation of two key activities. The first activity constitutes an examination of Malawi's four selected natural resources, namely forestry resources, fisheries resources, wildlife resources and soils. The primary purpose of this output is to provide evidence on the costs and benefits of sustainable and unsustainable natural resource management for these natural resources. The analysis also establishes linkages between natural resource management on the one hand, and poverty reduction, economic well-being and development on the other. The 2007 prices were used in the economic analysis.

In order to supplement the findings of the first output, the report also draws on case studies of three catchments, namely Linthipe, Lower Shire and Middle Shire. The three areas were selected in close consultation between the consultation team and the Technical Committee of the Malawi Poverty and Environment Initiative. The catchments are representative of Malawi's ecosystem in several respects: they include an area that is well rain-fed and endowed with rich soils, forest cover and fisheries resources, but that is also threatened by agricultural activities (Linthipe); an area that is crucial for hydro-power generation and endowed with rich wildlife resources but equally challenged by pressure on land, hence rapid degradation of forests and related resources (Middle Shire); as well as an area that is prone to both drought and flooding, albeit also being endowed with rich soil deposits, fish resources and other wildlife resources (Lower Shire). Focus was on assessing the impacts of soil degradation, deforestation, wildlife, as well as aquaculture on national development, food security and poverty. In order to accomplish this task, the methodologies included the calculation of agricultural land and water resources degradation rates and trends, calculation of forest depletion rates and trends; and preliminary calculation of fish depletion rates and trends.

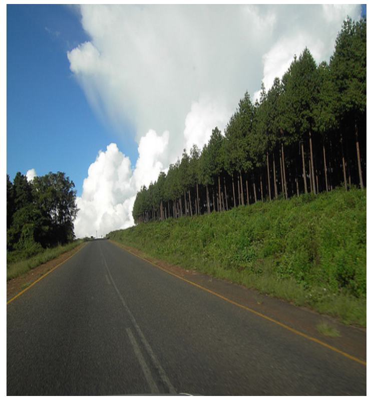
A comparative analysis of Satellite Images for 1994 and 2008 was conducted using Erdas Imagine 9.1 software to determine vegetation indices and soil degradation. The three catchments were also visited in May to July 2009 to consult relevant stakeholders, to validate the existing data and to generate new data where necessary. Relevant literature on the catchments was also consulted. These formed the basis of an impact analysis and assessments in agriculture, fisheries, wildlife and forestry.

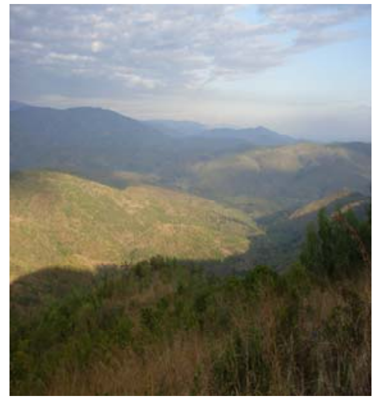
1.3 Organisation of the Report

This report is organised as follows. Section 2 provides an overview of the forestry sector. Focus is on the key characteristics of the sector, its socio-economic significance, threats to its sustainable utilisation, status of sector information, policies, legislation and activities, as well as implications for public policy. Section 3 provides an overview of the fisheries sector, and discusses the extent to which there is need for concerted efforts towards supplementing naturally attained fish stock levels. Section 4 contextualises the significance of topsoil in Malawi, and locates the depth of the problem of soil erosion, both in terms of extent and data for the analysis of implications. Section 5 provides a comparable overview for the wildlife sector.

Within Sections 2 - 5 we draw on case study and other evidence to assess the net benefits of key interventions to encourage more sustainable natural resource. In Section 6 we further draw on the foregoing sections to summarise the economic significance of natural resources in Malawi, and the poverty-environment linkages that can be established using this data.

2. Forestry Resources





A: Chikangawa Tree Plantation, Vipya Plateau.

B: Degraded sparse forest, Middle Shire

A: From www.ilovemalawi.blogspot.com as at 27/01/11

B: From Mlava *et al* (2009)

Forestry resources are crucial in supporting livelihoods, infrastructure development and energy in Malawi. Apart from providing a diverse range of wood and non-wood products, the sub-sector is important for soil and water conservation for agriculture and household use, provision of animal habitat, beautification of the countryside, enhancement of ecotourism and biodiversity, and regulation of climate change through, for instance, carbon sequestration. Little of this contribution is captured in GDP estimates and the officially reported contribution of the sub-sector to national output, at 1.8%, is certainly an understatement. The 2009 Malawi BEST study estimates that wood fuel alone accounts for an additional 4.3% of annual GDP. Full-time employment in forestry is around 29,000 with a further 130,000 jobs involved in wood fuel supply.

Royalties levied on forest products by Government amount to some MK163 million (US$1.17 million) annually - well below resource rents - because the rates do not reflect current market prices and collection of royalties and fees is limited, in part, by inadequate funding. Records suggest that the sub-sector currently only receives about one-fifth of its desired operating budget of US$1.79 million per annum.

Firewood is immensely important for household energy (providing 95% of rural household energy supply and 55% for urban households) with charcoal providing around a third of urban household energy supply. While forests are also an important source of various non-wood products (such as mushrooms, bush meat, fruits, juices, honey, and medicines), most of these are produced and used in the informal sector, and reliable estimates of quantities produced and their values are unavailable.

Official evidence suggests that forestry resources are degrading at a fast rate – 2.6% per annum. The principal cause is agricultural expansion driven by population growth. However, forest degradation for fuel wood (firewood and charcoal) is a significant problem in the catchments surrounding Lilongwe, Blantyre, Limbe and Zomba.

Using World Bank data for roundwood, excluding wood used for fuel, this study finds that the removal of roundwood faster than it grows costs MK3.1 billion (US$21.2 million) each year. The additional annual economic costs of excess roundwood use for firewood and charcoal in the major urban catchments are estimated at MK6.1 billion (US$42 million). Forests are likely to have a role in flood prevention but the science in this area is contested. We estimate that flood-related economic costs as a result of deforestation total up to US$1 million per year. There is consensus on the health impacts of indoor air pollution from burning firewood and charcoal, but the value placed on increased morbidity and mortality is open to discussion. We therefore estimate alternative scenarios for indoor air pollution costs but in the base case the annual cost is found to be MK3.3 billion (US$23.5 million), or just under 0.7% of GDP in 2007.

2.1 Characteristics of Forestry Resources

The total area of Malawi is 11.85 million hectares, of which 9.41 million hectares is land and 2.44 million hectares is inland water. According to FAO (2005), forestry resources covered an estimated 4.46 million hectares (or 47.4% of the total land area) in 1973, 3.60 million hectares in 2000, and 3.40 million hectares (or 36.2% of the total land area) in 2005. These figures appear to be higher than those reported in some official publications, but arguably more realistic[5]. More recently, the Malawi BEST (2009) claims that forests, woodlands and plantations constituted 21% of the total land area (excluding water) in 2008, but this estimate, too, was projected from the work of Satellitbild, conducted in 1973 and 1991 (see Department of Forestry, 1993), and excludes agriculture in forests. The wide variations in estimates of stock levels are a cause for concern, because the lack of accurate data hampers analyses and evidence-based policy formulation.

The country's forestry resources are unevenly distributed across its three regions which are roughly equal in terms of geographical area (see GoM, NASP[6], 2005). In 1996, it was estimated that 45% of the forestry resources were located in the Northern Region, where only 10% of the population leaves. The Central Region was home for 40% of the population and had 35% of the resources, while the remaining 20% was located in the most populous Southern Region (Gowela & Masamba, 2002).

Based on Gowela and Masamba (2002) and inclusive of 1.1 million hectares of area covered by national parks and wildlife reserves, an estimated stock level of 3.8 million hectares was distributed across resource types as shown in Table 1.

[5] For instance, the Annual Economic Report 2008 states that forestry resources cover 27% of the land area, while the Department of Forestry's State of Malawi Forests (2004) puts the figure at 26%. FAO (2005) notes that the prior estimates were an understatement due to a computational error. The GoM now recognises that 36% of the land area is forest cover (see, the Malawi Government's 2007 Millennium Development Goals Report).

[6] National Aquaculture Strategic Plan

Table 1: Distribution of Forestry Resources by Type

Resource Type		*Area ('000 ha)*	*% of Forest Area*
National parks and wildlife reserves[7]		1100	28.9
Natural Forests	Forest reserves	888	23.3
	Customary lands	1700	44.6
	Sub-total	2588	67.9
Plantations	Viphya	53	1.4
	Other Government	39	1.4
	Estate	14	0.4
	Woodlots	15	0.4
	Sub-total	121	3.2
Total		3809	100.0

Sources: Gowela & Masamba (2002); Kainja (2000). In our opinion, this could reflect the picture of around 1997-1998.

Thus, national parks and wildlife reserves constitute about 28.9% of the area covered by forestry resources, while 23.5% is covered by forest reserves. The remaining area is covered by natural woodlands on customary lands (44.6%) and plantation forests (3.2%).[8] These estimates compare favourably with those reported by Kambewa and Utila (2008), who noted that customary land constituted 50% of forest resources, while 47% was held by forest reserves, national parks and wildlife reserves, and the balance was in the form of plantations.

As with the rest of Southern Africa, Malawi's natural forests are covered by miombo (*Brachystegia*, *Julbernadia*, *Isoberlinia*) and munga (*Piliostigma*, *Acacia*, *Combretum*) species. It is estimated that the Department of Forestry manages over 918,000 hectares of natural forests held in about 88 forest reserves (FAO, 2005; Consortium AGRIFOR Consult, 2006).

Malawi has five national parks and four wildlife reserves which cover about 1.1 million hectares. The largest among these are Nyika (300,000 ha), Kasungu (200,000 ha), and Nkhotakota (150,000 ha).

Forest plantations have been the target of much development assistance in Malawi. The country's four main plantations are characterised as follows:

- Vipya Plateau in Northern Malawi, comprising 53,000 ha of largely pine plantation cover. The area of this plantation has expanded three times since 1972 (GoM, 2004).
- Zomba Mountain in Southern Malawi, comprising 3,600 ha of largely pine trees
- Dedza Timber Plantation in Central Malawi, comprising 1,771 ha of mostly pine species.
- Chongoni Timber Plantation in Dedza, Central Malawi, covering 4,106 ha, mostly comprising pine species.

Numerous smaller pockets of forest plantations, owned by the Government and the private sector, are widely distributed across the country. In total, the Government, through the Department of Forestry,

[7] This estimate excludes Lake Malawi Marine Park.

[8] The Annual Economic Report 2008 describes the distribution of forestry resources in terms of the total land area. We use this information to obtain estimates of the distribution as percentages of the total forest area. As with forest cover, these statistics vary from those reported in other publications.

manages over 90,000 ha of these plantations, while the industrial sector manages 97,000 ha[9]. The industrial sector holdings include 74,000 ha of pine for timber, and 23,000 ha mainly covered by eucalyptus species for firewood and poles (GoM, 2008).

2.2 Significance of Forestry Resources

2.2.1 General

The importance of forestry resources in supporting livelihoods in Malawi cannot be over-emphasised, but remains an area of great concern because of the unsustainable utilisation of the resources. In keeping with the MGDS priority area on Climate Change, Natural Resources and Environmental Management, the GoM's Ministry of Development Planning and Cooperation (MoDPC) recognises that the forestry sub-sector is directly linked to, and has an influence on, the attainment of other key priorities set in the MGDS. Apart from the key linkages with MGDS priority areas, forests are also important sources of employment and income, promoters of biodiversity that is important in ecotourism, and regulators of climate change.

Table 2 summarises government's position on the significance of forests within the context of the MGDS. The monetary values of each of these contributions are not known, but the estimated values of energy and timber products are discussed hereunder. The last column in Table 2 indicates the ecosystem services that this study attempts to place some values on.

The GoM (2008) reported that the joint contribution of forestry and fisheries to annual GDP was 3.0% in 2007. An examination of the original data[10] revealed that the implied contribution of forestry alone was 1.8%. In the following sections, it is shown that these figures represent a gross underestimation of the value of forestry resources. For instance, evidence from the Malawi BEST (2009) shows that woodfuel alone accounts for about 4.3% of GDP. This is buttressed by government's assertion that fisheries resources alone contributed about 4.0% to GDP in 2008 (GoM, 2009).The lack of reliable estimates of forestry's contribution to the economy is an observation that cuts across all natural and environmental resources, and reflects severe weaknesses in the national income accounting system and related valuation systems in Malawi.

2.2.2 Wood Production

According to the Department of Forestry, mobile saw millers and pit sawyers extracted an estimated 199,603 cubic metres (m^3) of wood worth about MK159.7 million (US$1.14 million) in 2007. In 2008, the extractions were estimated at 83,520 m^3 worth MK91.9 million or US$0.66 million (see GoM, 2008, 2009). These estimates are based on the department's own sales of trees and logs, and exclude sales by plantation holders, which are nonetheless quite limited[11]. In 2007, A further 48,745 m^3 of wood worth MK17.1 million (US$0.12 million) was used by commercial farmers, tobacco processors and other industrial users. These figures depict an upward trend in the significance of informal pit sawying. For instance, Kainga (2000) earlier reported that pit sawyers and mobile saw millers produced 17,580 m^3 of sawn wood from 80,000 m^3 log intake annually.

[9] Consortium AGRIFOR Consult (2006) reported a relatively higher government holding of 97,000 ha and a significantly lower private holding of 35,539 ha.
[10] This examination was conducted by Steve Makungwa.
[11] According to Dr Denis Kayambazinthu, Director of Forestry, mobile saw millers and pit-sawyers are allocated extraction quotas based on the capacities of their machines. These allocations are the basis on the estimates provided in the Annual Economic Reports.

Table 2: Contribution of Forestry to Selected MGDS Priority Areas

MGDS Priority Area	*Contribution of Forestry Sector*	*Proposed Valuation Method*
Agriculture and Food Security	- Control of soil erosion - Improvement of soil fertility - Mitigation during droughts and natural calamities	Case studies in 3 areas Case studies in 3 areas Case studies in 3 areas
Irrigation and Water Development	- Water catchment area for irrigation as well as domestic and commercial use - Improvement of water table for boreholes - Minimising siltation in rivers and lakes	Some limited amount of information from ESCOM and water boards
Transport and Infrastructure Development	- Supply of industrial timber and poles - Control of damage through flooding	Captured within timber revenues Some case study evidence
Energy Generation and Supply	- Supply of biomass energy - Protection of water catchment areas for hydroelectric power generation - Supply of transmission poles	Estimated from survey data Case study evidence Captured within timber revenues
Integrated Rural Development Programme	- Supply of timber and poles - Improvement of water table for borehole water supply	Captured within timber revenues Some limited amount of information from ESCOM
Prevention and Management of Nutritional Disorders, HIV and AIDS	- Supply of medicinal plants and food - Income source for the affected and the infected	Not captured Not captured

Sources: GoM (2008) and authors of this report.

The above production figures do not agree with those reported by the Food and Agriculture Organisation (FAO) as well as Malawi BEST (2009), both in terms of volume and value. FAO reports that 5,760,100 m^3 of roundwood was produced in 2007 (see www.faostat.fao.org). Even more divergently, Malawi BEST (2009:41) shows that 14,895,000 m^3 of roundwood is consumed annually, of which 13,643,000 m^3 is in the form of woodfuel (firewood and charcoal wood), and the rest is for poles and sawnwood (see

Table 3). At 130,000 m^3, the FAO estimate of production of sawlogs and veneer logs also falls significantly short of the estimate of sawnwood presented in

Table 3.

Table 3: Annual Roundwood production

Forestry Resource Use	*Total Consumption ('000m^3/year)*	*Estimated Value MK[2]*	
		MK m	*US$ m*
Charcoal[1]	1,999	8,440	57.0
Firewood[1]	11,644	17,350	117.2
Poles	975		
Sawnwood	280		

Total roundwood	14,895		

Source: Malawi BEST (2009).

Notes: 1. Figures include consumption by industrial and transport sectors

2. A shadow exchange rate of MK148.00 = US$1.00 was assumed in BEST (2009)

2.2.3 Energy Sources and Poverty

Due to high poverty levels as well as low coverage of electricity and other alternative sources of energy, biomass (firewood, charcoal, as well as crop and industrial residues) is the main source of energy. The National Energy Policy (2003) estimated that biomass accounted for over 93% of total energy consumption and about 99% of household energy demand in 2000. According to the Department of Forestry (GoM, 2008), firewood and charcoal respectively accounted for 80% and 8.8% of household biomass consumption. The other sources of energy included liquid fuels (accounting for only 3.5% of all energy sources), electricity (2.3%), coal (0.2%) and renewable energy (1%).

In an earlier study, the National Statistical Office (NSO, 2000) reported that 94% of Malawians used firewood and only 2% used electricity as their main sources of energy for cooking, while 90% used paraffin and only 5% used electricity for lighting. The situation in the rural areas was worse, with 98% using firewood and only 0.004% using electricity for cooking, while 93% used paraffin and only 0.01% used electricity for lighting. The Malawi BEST (2009) showed that the picture documented above had not changed significantly: biomass accounted for 88.5% of total energy consumption in 2008, only slightly lower than the 93% in 2000. Table 4 shows this more recent picture.

Table 4: Total National Energy Demand in Malawi, by Sector and Fuel Type

Sector	***Energy Demand by Fuel Type (TJ/yr)***					
	Biomass	***Petroleum***	***Electricity***	***Coal***	***Total***	
Household	127,394	672	1,798	5	129,869	83.4%
Industry	9,664	3,130	2,010	3,481	18,285	11.7%
Transport	270	5,640	35	15	5,960	3.8%
Service	452	558	477	174	1,661	1.1%
Total	***137,780***	***10,000***	***4,320***	***3,675***	***155,775***	
	88.5%	*6.4%*	*2.8%*	*2.4%*		

Source: Malawi BEST (2009).

The Malawi BEST (2009) further asserted that, in terms of total wood equivalent (t.w.e), the total demand for biomass energy in 2008 was 8.92 million t.w.e. (air dry) or about 13.38 million m^3 solid (or 24.3 million m^3 stacked), and that almost all of Malawi's current demand for energy was met from indigenous, renewable resources. The household sector accounted for over 90% of this demand. The study also estimated that the value of all traded woodfuel in 2008 was over MK15.5 billion (nearly $105 million), or 3.0% of GDP. Of this, MK2,950 million ($18.9 million) was the value of firewood and charcoal sold to the urban sector. In addition, an estimated 10.3 million m^3 of collected firewood for own-use could be valued to provide a combined value of traded and collected wood fuel of US$163 million, or 4.3% of 2008 GDP[12]. This calculation includes labour costs, shadow-priced where necessary at MK148 (US$1) per day. Thus, it includes the imputed labour cost of wood collection, typically

[12] These values were largely based on a survey of 851 households in 22 districts, representing the country's eight largest livelihood zones. The survey was conducted as part of the Malawi BEST development process. Additional data used in this valuation was obtained from a survey of small-scale enterprises: restaurants and resorts, brick burning operations, lime kilns, ceramic production, educational institutions, prisons, police stations, military barracks and hospitals.

incurred by women who have to travel long distances as forest depletion continues, sometimes at the expense of taking better care for their families.

To compare, Kambewa *et al* (2007) estimated that 6.8 million bags of charcoal were consumed in the four main urban areas of Malawi (Lilongwe, Blantyre, Mzuzu and Zomba) during the year of the study. In terms of household expenditure, the total value of this industry in the four areas was about MK5.78 billion (US$41.3 million), compared with MK1.62 billion (US$11.6 million) for electricity. Thus, this fraction of charcoal consumption in major urban centres accounted for around 1.2% of annual GDP[13]. In an earlier study, trade in wood fuel to the four main cities was found to provide 55,000 part-time employment and had a total value of approximately MK668.0 million (US$43.66 million) in 1996 (Openshaw, 1997; Lowore, 2006). The results of the BEST study would appear to be more appealing.

Examining the Malawi BEST (2009) results further, it is noted that household energy consumption in 2008 was 130,046 terra joules per year (TJ/yr), as summarised in Table 5. As already stated, 95.8% of the household energy demand was met through woodfuel sources (i.e., firewood and charcoal).

Table 5: Household Energy Consumption in 2008 (TJ/yr)

	Rural	***Urban***	***National***	
Firewood	105,320	10,560	115,880	89.1%
Charcoal	2,360	6,340	8,700	6.7%
Residue/dung	2,980	11	2,991	2.3%
Electricity	70	1,728	1,798	1.4%
Paraffin	240	430	670	0.5%
Coal	0	5	5	0.0%
LPG	0	2	2	0.0%
Total	110,970	19,076	130,046	100.0%

Source: Malawi BEST (2009)

The household sector's expenditure on woodfuel could be estimated at US$157.2 million in 2008, representing 4.2% of GDP (

[13] Malawi's GDP was estimated at US$3.5 billion in 2007 according to the World Bank.

Table 6). An alternative estimation procedure is as follows: The National Statistical Office estimated that there were 2,731,346 households in Malawi in 2005, with an average income of about MK51,000 (US$363) per annum (NSO, 2005). Assuming that the number of households grew at the population growth rate of 2.6% per annum (as established in the 2008 population census) to just about 2.95 million in 2008, it can be estimated that household expenditure on woodfuel in 2008 was about US$169.8 million, or US$57.55 per household. If we disregard income inequalities and apply the average annual real GDP growth of 6.5% per annum between 2005 and 2008 (see Mangani, 2011), average household income may have grown to US$439 in 2008. As such, expenditure on woodfuel may be 13.1% of total household expenditure. However, given high inequalities in income distribution, it is clear that such expenditure is a significant proportion of rural household incomes than those of urban households, and of female headed than male-headed ones. NSO (2005) noted that urban households had over three times higher incomes (US$924 against US$287), while those of male-headed and female-headed household incomes were at US$400 and US$241, respectively.

Table 6: Calculation of Household Expenditure on Woodfuel in 2008

Total volume of woodfuel consumption (TJ/yr)	129157
Total value of woodfuel consumption (US$)[1]	163,000,000
Volume of household woodfuel consumption (TJ/yr)	124582
Household woodfuel consumption (% of total volume)	96.6
Value of household woodfuel consumption (US$) = 96.6% of total value	157,226,200
Value of household woodfuel consumption (% of GDP)	4.2%

Source: Calculated in this study using data from Malawi BEST (2009)

Note: 1. Based on the result that the total value of woodfuel constituted 4.3% of GDP in 2008

2.2.4 Employment

The Department of Forestry reports that forestry employs an estimated 29,000 people, of whom 20,000 are in the informal sector dominated by carpentry and pit-sawing activities. It is further estimated that 92,800 people owe their livelihoods to charcoal, through production (46,500 people), bicycle and other transportation (12,800 people), and trading (33,500 people). About 38% of all the charcoal is produced by some 338 large-scale producers, 27% by medium scale producers, and 35% by small-scale producers (GoM, 2008). These figures remained unrevised for 2007 and 2008 (GoM, 2008; 2009)[14], but compare favourably with those provided by the Malawi BEST (2009) which asserted that:

> "The estimated full-time employment in traded wood fuel from the growing to the selling is nearly 130,000, of which charcoal accounts for 57 percent. Of course, many producers are not 'full-time', therefore the number of people involved in commercial wood fuel production etc. could be in the region of 180,000 to 200,000".

2.2.5 Value of Timber Products

Comprehensive and up-to-date data on the values of timber products is not available. As an attempt, Kainga (2000) noted that the formal processing sector required an annual log intake of 120,000 m^3 with conversion efficiency of about 50%. Based on this intake, the final primary processing output measured about 64,000 m^3, and was worth US$5.5 million (see Table 7). He further asserted that value-addition from secondary processing of wood products was worth US$4.0 million per annum, which was allegedly 0.5% of annual GDP. Therefore, the annual formal output of primary and secondary timber processing was estimated at US$10 million. The informal sector also produced an estimated US$1.5 million worth of mechanical wood products.

Table 7: Final Primary Processing Output

Final Product	*Annual Production (m^3)*	*Value (US$ million)*
Sawn timber	31, 000	2.2
Furniture	10,000	1.5
Value added products	15,000	2.0
Poles	8,000	0.8
Total	***64,000***	***5.5***

Source: Kainga (2000:19).

[14] Worrisomely, the relevant paragraph in the Annual Economic Report 2009 is replicated verbatim from the 2008 version.

Table 8: Value of Timber Products

Product			Value (US$ million)	Value (% of GDP)
Formal sector			10.0	1.25
	Of which:	primary products	5.5	0.69
		secondary products	4.0	0.50
Informal sector products			1.5	0.19
Total			***11.5***	***1.44***

Source: Estimated in study using data from Kainga (2000).

2.2.6 Foreign Exchange and Revenue

Forestry products are also a source of foreign exchange, albeit at a limited scale. Kainga (2000) reported that about US$0.6 million worth of processed forestry products (mostly softwood logs and peeler logs) were exported annually. On the other hand, Malawi's importation of paper alone was worth US$60 million per annum within the same period. More recently, FAOSTAT (2009) report that the total export value of forest products in 2007 was US$8.4 million, while imports were worth US$19.3 million. Thus, Malawi is clearly a net importer of forest products. Enhanced production and sustainable investments in value-adding use of the resources could assist in saving the country's severely limited foreign exchange.

Forestry products also generate government revenue. Table 9 depicts the trend in government revenue from this resource. Most of this revenue is from royalties on forestry produce, sales of logs and firewood, sales of forestry produce on customary estate, and administration fees.

The calculation of royalties is based on gazetted guidelines that include all costs involved in the management of the plantations per hectare[15], which are then extrapolated to costs per cubic metre and, eventually, per tree. The royalties collected are too low to cover the costs, because the rates applicable are gazetted and do not reflect market prices. In addition, the collection of royalties and fees is ineffective because of the inadequacy of resources to enforce rules. The common tendency is for people to extract more than what they will have paid for, taking advantage of laxity in policing. Finally, the revenue collected by the department is not used to enhance sustainable management of forestry resources, because it goes into the government's common pool. The structure of fees and royalties was under review during the study period.

Table 9: Government Revenue from Forestry Resources

	Estimate		*Actual*	
Financial Year	***MK (million)***	***US$ (million)***	***MK (million)***	***US$ (million)***
2004/05	180.2	1.45	164.3	1.32
2005/06	170.3	1.22	154.0	1.11
2006/07	170.3	1.21	150.2	1.07
2007/08	200.0	1.42	202.9	1.44
2008/09*	221.2	1.58	163.2	1.17

Sources: GoM (2008; 2009). * is revenue collected as at May 2008. US$ values are based on end of period official rates.

[15] These are labour costs, fuel and other operational costs, as well as maintenance costs. Harvesting costs have recently been taken out because the Department of Forestry is no longer undertaking tree harvesting.

2.2.7 Non-Wood Forest Products

As with all other forestry products, reliable information on the significance of non-wood forest products (NWFP) is scanty. However, the increasing importance of NWFP in supporting rural livelihoods is well recognised. Increasing the sustainable utilisation of NWFP is considered key in establishing a positive linkage between the welfare of rural communities and the conservation of forests (Chanyenga, undated). Chanyenga summarises the regional distribution of the key NWFP follows:

- *Northern Region:* bushmeat, honey, caterpillars, termites;
- *Central Region:* mushrooms and fruits;
- *Southern Region:* termites, honey, caterpillars.

This listing is, however, scanty since the various NWFP are produced in various quantities across the country. Thus, although mushrooms are not listed as a key NWFP in the South, Wong and Pouakouyou (undated) document evidence that this product is key in the Liwonde Forest Reserve where, based on five sites studied in 2002, mushroom productivity averaged 58.17kg/ha over a growing period of 24 days from a possible 90 days. Other NWFP worth mentioning are beewax, medicines, fodder and thatching grass.

Table 10 lists some of these NWFP and attempts to provide their production levels and estimated values. Since most of these are transacted in the informal sector, the scanty information in the table could be a gross misrepresentation of the real picture, highlighting the importance of fieldwork. The references cited provide descriptions of the status of relevant NWFP.

Table 10: Production and Values of Selected NWFP

	Annual Production			
Product	***Quantity p.a.***	***Value p.a.***[16]		***References***[17]
		MK (million)	***US$***	
Ornamental flowers	30,510 plants	7.28	90,440	K
Fruit juice (1998/99)	212,655 kg	0.19	2,360	K, KU
Fruit juice (1999/00)	126,750 kg	0.20	2,484	K, KU
Honey	1000 tonnes	59.85	43 million	C & author[1]
Bee fax	150 tonnes			

Note: Estimated using shelf price

In addition, using the foregoing information provided by Wong and Pouakouyou (undated), this study extrapolates that the production of edible mushroom in Liwonde Forest Reserve in 2002 was 218.12 kg/ha over a 90-day growing season, valued at MK54/kg (US$0.72/kg). Based on the estimated coverage of forest reserves at 888,000 ha (see Table 1), and assuming that the Liwonde experience is representative of all forest reserves, this gives a total edible mushroom production of 193.7 million kg, which could be valued at US$139.5 million (MK19.5 billion). As the Southern Region (where Liwonde is

[16] In the absence of a clear indication regarding years of data compilation, the exchange rate used was for end 2000 (i.e., MK80.4951 = US$1.00).

[17] The references give publications in which detailed information on these NWFP can be found: K = Kainga (2000), C = Chanyenga (undated), L = Lowore (2006), KU = Kambewa & Utila (2008). Where appropriate, annual production data are from the first reference cited.

located) is not listed as a mushroom growing area by Chanyenga (undated), it is possible that these estimates are not exaggerated.

Additional estimates of selected NWFPs are presented in Annex 8 in the context of a discussion on the wildlife sub-sector.

2.2.8 Flood Prevention

There is evidence from small-scale catchment studies that forests can prevent rainfall-induced flood generation by increasing interception loss (direct evaporation of rainfall intercepted by the canopy), reducing infiltration into the soil and increasing retention of infiltrated water[18]. Deforestation is therefore often associated with increased flooding. However, the science in this area is contested. International evidence from a 2005 study of deforestation and flooding in 56 developing countries suggests that this form of environmental degradation increases both the risk and severity of flood damage[19]. A 10% decrease in natural forest cover was found to increase flood frequency from 4% to 28%[20]. Yet, another review by FAO and CIFOR concluded that forests cannot stop catastrophic large-scale floods caused by severe weather events (FAO, 2005).

Many households along the Shire River have suffered the effects of floods. In the floods of 2001, for example, 500,000 people were negatively affected[21]. Yet ,as those affected are typically poor farmers, the economic loss that results is limited by the low financial value of what they grow, as well as their basic housing and limited access to infrastructure[22]. Data on the economic damage from flooding in Malawi is held within the CRED international disaster database[23]. Analysis of this data shows that over the decade 1991 - 2001[24] the economic cost of flooding was approximately US$32 million (MK4.6 billion), arising from flood occurences in 1991, 1998, 2000 and 2001. From this we can say that the expected cost of flooding in any one year is MK464 million or US$3.2 million.

In order to calculate the potential magnitude of deforestation on flooding costs, consider that Malawi has lost over 50% of natural forest in the middle and lower Shire since 1973. As noted above, linking the economic cost of flood events to increases in incidents as a result of deforestation is challenging because there is disagreement concerning the role of forests in preventing flooding. Our approach is to present a range of estimates. At the lower end, there is no impact and at the upper end deforestation results in up to a 30% increase in flooding. Given the expected cost of flooding presented above, if deforestation in the lower and middle Shire catchments were to translate to an increased flood frequency of 25%, the expected economic cost in any one year would be approximately MK116 million or US$800,000. Flood-related economic costs are therefore likely to lie in the range US$0 – US$1million per year (0 – 0.28% of GDP).

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[18] See FAO (2005) Forests and floods: drowning in fiction or thriving on facts? Forest Perspectives, 2, RAP Publication 2005/03,. FAO, Rome.
[19] Bradshaw et al (2007)
[20] Ibid
[21] http://www.preventionweb.net/english/countries/statistics/?cid=104
[22] The economic impact of a disaster usually consists of direct (e.g. damage to infrastructure, crops, housing) and indirect (e.g. loss of revenues, unemployment, market destabilisation) consequences on the local economy. See: http://www.emdat.be/explanatory-notes
[23] http://www.emdat.be
[24] The most recent period for which data is given by http://www.preventionweb.net

2.3 Threats to Forestry Resources

2.3.1 Deforestation

Given the aforementioned significance of forestry resources in supporting livelihoods, sustainable utilisation is a challenge and forest degradation is a serious problem in Malawi. Studies conducted by Satellitbild for the Department of Forestry between 1973 and 1991 showed that, over that period, the country lost about 2.5 million of its 4.4 million hectares of forest cover, representing an annual deforestation rate of 2.8%. Table 11 summarises this picture. It is officially estimated that forestry resources are declining at the rate of 2.6% per annum (GoM, 2008)[25]. However, the case study evidence generated for this study (see Mlava *et al*, 2010) suggests that deforestation in three parts of the country averaged 1.46% per annum between 1994 and 2008, and varied as follows:

- Linthipe Catchment: 0.67% p.a.
- Middle Shire Catchment: 2.12% p.a.
- Lower Shire Catchment: 1.59% p.a.
- Average: 1.46% p.a.

Despite not being nationally representative, these recent case study results could suggest that official deforestation figures are overstated, and/or that national initiatives to curb deforestation are bearing some fruit. A full-scale national study could provide a clearer picture.

Table 11: Deforestation between 1972 and 1992

Region	*1972 Forest Cover (million ha)*	*1992 Forest Cover (million ha)*	*Loss of Cover (million ha)*
North	1.51	0.47	1.02
Centre	1.49	0.78	0.71
South	1.40	0.65	0.75
Total	4.40	1.90	2.50

Source: Department of Forestry (1993)

Agricultural expansion is one clear source of the degradation of forestry resources, reflecting the deliberate long-standing national policy objective of setting agriculture as the mainstay of the economy. Openshaw (1997) reported that about 2.5 million hectares of forest land were converted into agricultural land between 1946 and 1996.

[25] In 1996, the Ministry of Natural Resources estimated that the annual rate of deforestation was in the range of 1.0%-2.8%, varying across different parts of the country and across different types of forestry resources.

Table 12 summarises the upward trend in agricultural land as a percentage of the total land area. While this percentage grew by an average of 0.35% per annum over the period from 1961 to 2003, it is alarming to note that this rate was highest (1.24% p.a.) in the last three years to 2003.

Table 12: Agricultural Land Expansion in Malawi

Year	*Agricultural Land (% of Total Land)*
1961	32.31
1970	33.38
1980	36.56
1990	40.07
2000	43.47
2003	47.19

Source: World Development Indicators Database as reported at www.nationmaster.com on 10 July 2010

The Malawi BEST (2009:5) presents an even more pessimistic picture, as follows:

> "Reflecting the fact that 90% of Malawians rely on smallholder agriculture for their livelihoods, 70% of the country's land area is under some form of agriculture, up from 62% in 1991".

More specifically, Malawi BEST (2009:6) reports that 669,000 ha of forest and woodland as well as 152,000 ha of grassland were lost between 1991 and 2008. Of this, only 7,700 ha was lost due to urban development and other miscellaneous use, while the rest is fully attributed to agricultural expansion. This suggests that close to 99% of deforestation is attributable to agricultural expansion, and implies that charcoal/woodfuel production almost relies on stock already lost due to agricultural expansion. In contrast, Kambewa et al (2007) attribute around a third of deforestation to charcoal production. We must certainly recognise the interaction between charcoal production and agricultural expansion. For example, being paid for charcoal production may make it economic to clear land for agriculture.

The case study evidence in Mlava *et al* (2010) is mixed. Box 1 shows that, on average, 58.47% of the total land in the three catchments was under cultivation in 2008, and this was expanding by an average of 0.93% per annum, which is lower than that recorded in the studies documented above. However, the expansion was quite high in the Lower Shire catchment (1.5% p.a.), but lowest in the Linthipe catchment (0.12% p.a.).

Box 1: Agricultural land estimates from case studies

	Agricultural Land	
	% of Total in 2008	***1994 – 2008 Increase***
Linthipe Catchment	59.0	0.12 % p.a.
Middle Shire Catchment	65.7	1.16 % p.a.
Lower Shire Catchment	50.7	1.50 % p.a.
Average	58.47	0.93 % p.a.

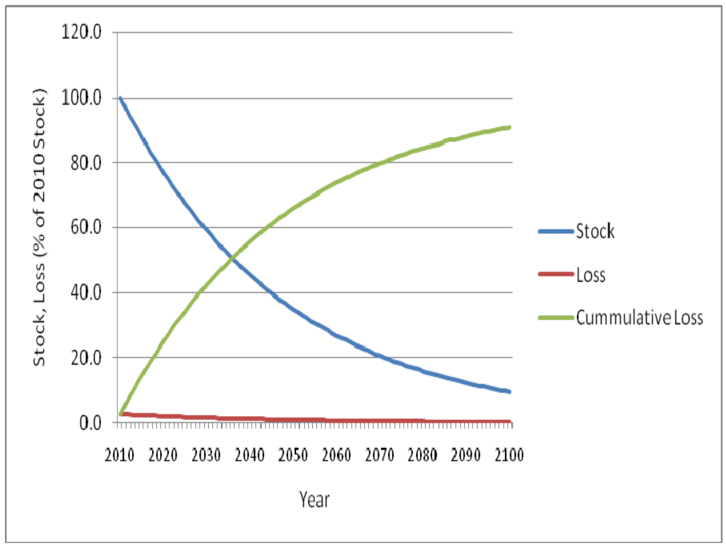
Source: Mlava *et al* (2010)

In relation to agricultural expansion, excessive degradation is clearly attributable to poverty, population growth, infrastructural development, inappropriate management, poor policies (especially in the past), and limitations in governmental capacity in policy implementation and legislation enforcement. The first two are directly linked to high charcoal production levels, among other pressures.

As a result of the high dependence on biomass energy sources, the Department of Forestry (GoM, 2008) argues that the national demand for firewood and charcoal, estimated at 7.5 million tonnes per annum, is way in excess of the sustainable supply of only 3.7 million tonnes per annum.. Even more generally, the Malawi National Forestry Programme (GoM, 2001) argues that the demand for forestry products, estimated at 15million m^3, far exceeds the estimated supply of 7-8 million m^3. Due to this and all other sources of deforestation, it is estimated that between 50,000 ha and 75,000 ha of natural forests are destroyed annually (GoM, 2008). At the official rate of deforestation (2.6% p.a.), it would take only 36 years to deplete one half of all the available forestry resources, and 62 years to remain with just a quarter. In 98 years, less than 10% of the current stocks would be in existence, unless the rate of deforestation is reversed (see Figure 2). Given the socio-economic significance of the sector already discussed, it is clear that a continued reduction in stock levels would have adverse effects on future employment and income levels (hence exacerbate poverty), and deprive future generations of key energy sources, timber and other NWFP.

Although tree planting and plantation rehabilitation programmes have been on-going for many years (see Annex 3), the total area planted with trees each year is always less than the loss due to deforestation. Table 13Table 14 shows that the tree planting exercises replenish less than one half of the total stock loss per annum, and that there is stagnation in the number of trees planted each year. It is conceivable that opportunities for carbon trading could assist in addressing this trend. Annex 3 discusses this and related initiatives.

Figure 2: Projected Impact of Deforestation on Stock Levels



Note: This figure has been generated in the study, assuming that deforestation will remain constant at 2.6% p.a. of the previous year's balance of forest cover.

Table 13: Shortfall in Tree Replenishment

	2002/03	*2006/07*	*2007/08*
Trees planted (million)	52.9	51.7	52.8
Area planted with trees (ha)	24,890	20,699	21,102
Estimated survival rate (%)*	60	60	60
Area covered by surviving trees (ha)	14,934	12,419	12,661
Industrial plantation area rehabilitated (ha)		1,831	1,400
Estimated total deforestation rate (ha p.a.)	32,000	50,000	50,000
Estimated net deforestation rate (ha p.a.)*	17,066	35,750	35,939

Source: Constructed in this study from various GoM sources; estimates marked * are from Annual Economic Reports.

2.3.2 Fires, Pests and Low Survival Rates

In addition to the severe problem of deforestation arising from human activity in support of livelihoods, bush fires are a great threat to forestry resources. These fires, mostly known to be started by people in the course of clearing fields and cattle grazing, or in the process of hunting and honey harvesting, tend to have disastrous effects. The largest number of fires in recent times is recorded to have occurred in 1995 when 13,900 hectares of forest land were destroyed in 109 incidences, which cost MK104 million, or US$6.80 million (GoM, 2008; Consortium AFRIFOR Consult, 2006). In addition to the direct loss of forest cover, forest fires cause smoke haze, pollution, as well as loss of seedlings and biodiversity.

Exotic pests are another threat to forestry resources, especially plantations. In 1989, it was estimated that 30% of wood production was lost to pine needle pest, while wood loss due to pine woolly aphid was valued at US$2.6 million in 1990 (Consortium AFRIFOR Consult, 2006).

In terms of new community plantations, poor management resulting from lack of ownership tended to reduce the survival rates of planted trees to less that 60%, but significant improvements in this regard have been registered since the adoption of appropriate national policies in 1996.

2.3.3 Inadequate Funding

The Department of Forestry received ORT[26] allocations of MK57.2 million (US$0.41 million) in 2007/08 and MK61.2 million (US$0.44 million) in 2008/09, against a proposed budget of K250 million (US$1.79 million) that would be required to carry out its activities effectively (GoM, 2008; 2009). On average, the department's ORT budget over the period from 2002/03 to 2007/08 was at MK50 million per annum, and increased annually by a mere MK4 million (Table 14). In US dollar terms, the average annual allocation was $0.42 million, and increased annually by a meagre US$28,571. Clearly, the department is severely underfunded, a situation that harshly limits its ability to enforce rules and play a leading role in securing the proper management and sustainable utilisation of forestry resources. This situation is worsened by the fact that about 18% of established positions within the department were vacant in 2008/09, according to the Output-Based Document of the 2008/09 Malawi Government Budget. However, the funding problems are somewhat reduced by the availability of programme or project funding, as discussed under forestry subsector programme/projects in Annex 3.

Table 14: ORT Allocations to the Department of Forestry

Year	*ORT Allocation (MK Million)*	*ORT Allocation (US$)*
2002/03	37.4	0.43
2003/04	38.4	0.36
2004/05	53.9	0.49
2005/06	48.2	0.39
2006/07	53.4	0.39
2007/08	57.2	0.41
2008/09	61.2	0.44

Source: GoM, Annul Economic Report (2008, 2009). US$ values are based on mid-year exchange rates (e.g., Dec 2002).

To summarise and emphasise, deforestation is occurring at the rate of 2.6% per annum (but a figure of 2.12% is reported for the Lower Shire catchment), largely on account of agricultural expansion, poverty and population growth. All these are matters on which government commitments have already been well articulated in national and sectoral policies and strategies, although their

[26] Other recurrent transactions – part of the recurrent (rather than development) budget that excludes personal emoluments.

implementation is usually challenged by many factors, including poor management, inadequate prioritisation of public resources, and financial constraints. A review of the legal and regulatory environment (see Annex 2) shows that significant efforts are being made to improve the management and sustainable utilisation of forestry resources, particularly since the formulation of the Forestry Policy in 1996. Together with the Forestry Act of 1997, this policy has increased the participation of local communities and the private sector in forestry resource management. Yet, inadequate public resources limit the Department of Forestry's ability to curb the threats in tandem with the provisions of the legal and regulatory instruments.

3.3.4 Effects of Climate Change

Malawi finalised its National Adaptation Programme of Action (NAPA) in 2006 as part of the process of preparing for the adverse effects of climate change. NAPAs are intended to provide a process for least developed countries to identify priority activities that respond to their urgent and immediate needs with regard to adaptation to climate change, focusing on enhancing adaptive capacity to climate variability. The Malawi NAPA includes coverage of forestry resources. As a build-up to the process of NAPA preparation, the country was a signatory to the United Nations Framework Convention on Climate Change (UNFCCC) in 1992, and submitted its Initial National Communication under UNFCCC in 2003 (hereinafter, GoM, INC, 2003). This Initial National Communication was informed by technical work that used global circulation models (GCMs) and other tools to project temperature and rainfall for the years 2020, 2075 and 2100, and to assess the socio-economic effects of such projections on water, agriculture, forestry, fisheries and wildlife. These projections became important inputs into the preparation of the NAPA. However, most of this work was conducted around 1994, lacked quality data and had methodological limitations. Thus, the vulnerability and assessment results ought to be interpreted with caution. The key results of the studies were that:

a) Temperatures were predicted to increase by between 1°C and 3°C;
b) Rainfall could increase by between 5% and 22%, or decrease by between 1% and 16%, depending on model used and location;
c) Runoff was predicted to decline, especially in the Linthipe Basin; and
d) The amount of water in each river basin would be higher than that required for irrigation and domestic use.

For the forestry sector, the vulnerability and assessment was undertaken in Dzalanyama Forest Reserve whose coverage of species is broad. The results of this work may not be easily replicated to other forests, but indicatively predicated as follows (see GoM, INC, 2003):

- Forestry specie composition would change in favour of those adapted to drier conditions by 2020;
- Wood production could decline by about 37% per hectare between 2020 and 2100, but this situation could be worse under extreme climate change scenarios.

2.4 Costs of the Unsustainable Use of Forest Resources

2.4.1 Unsustainable Roundwood Use (Excluding Fuelwood)

The sub-sections above have documented the varying estimates of forest use for timber and poles. In estimating the economic costs of unsustainable use for roundwood excluding fuelwood we use the official roundwood figures as reported to FAO. The difference between actual and sustainable offtake is estimated by the World Bank (2006) and this is valued at the prices reported by FAOSTAT and the World Bank. These figures are shown in Table 15 below. The annual cost of unsustainable roundwood use for purposes other than fuelwood is approximately MK 3.1 billion (US$ 21 million) in 2007 prices or 0.4% of 2007 GDP.

Table 15: Estimated Costs of Unsustainable Roundwood Use (excluding fuelwood)

Weighted Av. Unit rent for roundwood (US$/$m^3$)[1]	12.25
Sustainable Increment for roundwood (m^3)[1]	4,026,629
Total roundwood production - excluding fuelwood (m^3)[2]	5,760,000
Excess demand for roundwood excluding fuelwood (m^3)	1,733,371
Annual value of excess roundwood production (US$)	21,233,303
Annual value of excess roundwood production (MK)	3,099,752,197
Annual value of excess roundwood production as share of 2007 GDP	0.39%
Discounted cost over 10 years (MK)	12,710,091,536
Discounted cost over 10 years (US$)	87,064,127
Discounted cost over 10 years as share of 2007 GDP	2.44%

1. Source: WB, 2006
2. Source: FAOSTAT/WB 2006

2.4.2 Unsustainable Fuelwood Use

The analysis of BEST (2009) shows that wood demand for firewood and charcoal only exceeds sustainable supply in areas surrounding the major urban centres i.e. in the Blantyre, Lilongwe, Limbe and Zomba catchments. This estimate of excess demand is shown in Table 16 below. We know from user surveys (see Kambewa et al, 2007) that nearly all charcoal is traded and some firewood is traded although in rural areas it is generally collected for own use. What we do not know is the proportion of fuelwood (for charcoal and firewood) that is traded in the urban catchments concerned. Hence, using the data provided by BEST (2009) we estimated the cost of excess fuelwood demand using three scenarios in Table 16:

- Lower bound – all fuelwood is collected – with an annual cost of MK 1.9 billion (US$ 12.8 million)
- Upper bound – all fuelwood is traded – with an annual cost of MK 10.3 billion (US$71 million)
- Mid-point – 50% of fuelwood is collected and 50% is traded – with an annual cost of MK 6.1 billion (US$ 42 million)

In order to illustrate how the costs of failure to tackle the problem mount up over time we calculated the discounted cost over 10 years (using a 10% discount rate) for each option.

Table 16: Estimated Costs of Unsustainable Fuelwood Use

Annual fuelwood excess demand - Lilongwe catchment (m^3 million); see BEST 2009 Table 29	1.15
Annual fuelwood excess demand - Blantyre/Zomba/Limbe catchments (m^3 million); see BEST 2009 Table 29	1.1
Total value of traded fuelwood (MK); see BEST 2009 Table 21	15,502,000,000
Total estimated value of collected firewood (MK); see BEST 2009	8,570,000,000
Total estimated quantity of traded fuelwood (m^3); see BEST 2009 Table 20	3,384,700
Total estimated quantity of collected firewood (m^3); see BEST 2009	10,300,000
Average value of traded fuelwood MK/M^3	4,580
Average value of traded fuelwood US$/$M^3$	31
Average value of collected firewood MK/M^3	832
Average value of collected fuelwood US$/$M^3$	6
IF ALL COLLECTED (LOWER BOUND)	
Annual value of total excess fuelwood demand – MK	1,872,087,379
Annual value of total excess fuelwood demand - US$	12,823,799
Annual value of total excess fuelwood demand as share of 2007 GDP	0.36%
Discounted cost over 10 years – MK	7,676,227,141
Discounted cost over 10 years - US$	52,582,156
Discounted cost over 10 years as share of 2007 GDP	1.48%
IF ALL TRADED (UPPER BOUND)	
Annual value of total excess fuelwood demand – MK	10,305,049,192
Annual value of total excess fuelwood demand - US$	70,589,587
Annual value of total excess fuelwood demand as share of 2007 GDP	1.98%
Discounted cost over 10 years – MK	42,254,383,636
Discounted cost over 10 years - US$	289,442,528
Discounted cost over 10 years as share of 2007 GDP	8.13%
MID-POINT ESTIMATE	
Annual value of total excess fuelwood demand – MK	6,088,568,285
Annual value of total excess fuelwood demand - US$	41,706,693
Annual value of total excess fuelwood demand as share of 2007 GDP	1.17%
Discounted cost over 10 years – MK	24,965,305,388
Discounted cost over 10 years - US$	171012341.9
Discounted cost over 10 years as share of 2007 GDP	4.80%

Source: Authors' calculations using data presented in BEST (2009)

2.4.3 Cost of Indoor Air Pollution

Based on an extensive review of the medical, rural energy and development literature, Hutton et al (2006) analyse the costs of indoor air pollution and benefits from switching away from fuel wood and charcoal in terms of six key variables as follows:

Variables used in the WHO study of the economic impact of indoor air pollution

Variable	Immediate cost or impact	Delayed cost or impact[a]
Intervention costs	Stove purchase cost and house alterations (investment), fuel recurrent costs, programme costs	NA
Health benefits and health care cost savings	ALRI	COPD Lung cancer
Productivity gains due to morbidity	Related to ALRI	Related to COPD and lung cancer
Value of deaths averted	NA	Related to ALRI for children,[b] and to COPD and lung cancer for adults > 30 years
Time savings	Fuel-collection time and cooking time	NA
Environmental benefits	Local and global environmental benefits[c]	NA

NA, not applicable; ALRI, acute lower respiratory infection; COPD, chronic obstructive pulmonary disease.

[a] Costs and impacts are discounted at a rate of 3% by the number of years into the future when they are predicted to occur.
[b] The economic impact of preventing ALRI is delayed because income-earning life is assumed to start at the age of 15 years.
[c] The environmental benefits can also be indirect and long-term, but only short-term impacts are included.

Source: Table 4, Hutton G, Rehfuess E, Tediosi F, Weiss S. *Evaluation of the costs and benefits of household energy and health interventions at global and regional levels.* Geneva, World Health Organization, 2006

The proportion of the population assumed to be using traditional fuels such as firewood and charcoal for the 20 countries of the AFR-E subregion (including Malawi) is as follows:

WHO subregion	Solid fuel								Traditional stove	
	Coal/lignite		Charcoal		Firewood		Dung and agricultural residues			
	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural
	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
AFR-D	2.8	0.6	16.2	4.0	28.1	41.0	31.5	49.5	92.0	98.6
AFR-E	8.8	1.6	15.1	15.0	24.6	57.9	4.4	12.1	86.6	94.3

Source: Extract from Table 2, Hutton G, Rehfuess E, Tediosi F, Weiss S. (2006)

Estimated health impacts in Hutton et al (2006) are based on three published studies that have compared personal exposures of children living in homes using open fires with those of children living in homes using improved stoves, giving a *35% reduction in personal exposure*. Health-system unit costs of patient care are extracted from a study of health-care unit costs at sub-regional level supplemented by sub-regional data on additional costs of medicines and procedures. To avoid the overestimation of expected cost savings, the authors use actual or expected treatment-seeking rates for each disease.

As well as the saving in health-care costs, reducing indoor air pollution and days lost to illness allows more time to be spent on productive activities. Their study values the economic benefits of reduced morbidity as the number of days of illness averted multiplied by an average time value for each WHO sub-region[27]. The economic benefit of averting early deaths (reduced mortality) is estimated as the discounted value of lost adult work years using GNI per capita.

The authors assume that interventions lead to two types of time saving – from reduced fuelwood collection time and from reduced cooking time. These time savings (for both adults and children) as well as the value of reduced morbidity and mortality are valued at the weighted average GNI per

[27] Hutton G, Rehfuess E, Tediosi F, Weiss S. (2006), *Op. Cit.*

capita by sub-region[28]. Other valuation variables are very conservatively estimated but using GNI per capita tends to overstate the value of rural labour i.e. the implied daily wage is US$18.67, far in excess of that available to most firewood or charcoal users. For this reason the indoor air pollution cost estimates produced by Hutton et al (2006) should be taken as upper bound estimates.

We could draw on the analysis presented by Hutton et al (2006) to assess the benefits of switching from current practice to improved stoves29 to provide an estimate of the cost of indoor air pollution. Table 17 below provides their estimates of benefits gained from reducing fuelwood use when 50% of the sub-regional population switch to fuel efficient stoves.

Table 17: Estimated Benefits of a 50% Improvement in Access to Improved Stoves for the AFR-E Region, 2006 – 2015:

Annual saving (US$ million) 2005 prices	***Improved stove (scenario III) – for AFR-E region***		
	Urban	***Rural***	***Source: Hutton et al (2006)***
Fuel cost saving	2213	511	Table 14
Health system cost saving	1	2	Table 15
Patient cost savings	0.1	0.2	Table 16
Value of fuel collection time savings	583	1881	Table 19
Value of cooking time savings	1507	1342	Table 21
Value of sickness time avoided	19	32	Table 24
Value of deaths averted	193	283	Table 26
National environmental costs averted	119	212	Table 28
Global CO_2 costs averted	54	93	Table 29

In order to produce an estimate of the health costs of indoor air pollution in Malawi from fuel wood we were only interested in a sub-set of the results presented in Table 17. Estimates of other costs (such as environmental costs) are presented elsewhere in this Chapter using more accurate, Malawi-specific data. Hence, we looked to the table below for:

- Health system & patient financial costs;
- Loss of productivity from increased sickness (morbidity); and
- Loss of work years from early deaths (mortality).

In order to turn these into cost estimates for Malawi we needed to:

- Use the US CPI to turn 2005 into 2007 prices[30]
- Double their value to allow for 100% coverage (rather than 50% switching to fuel efficient stoves); and
- Use the UN forecast that Malawi's projected population in 2015 will be 3.36% of the total projected population of the AFR-E region[31]

[28] *Ibid.*
[29] As the fuel mix (firewood and charcoal) used by the population is unchanged. In contrast, a switch to LPG changes the proportion of the population using traditional fuels.
[30] http://www.bls.gov/cpi/tables.htm. We use the US CPI rather than the Malawi CPI as the base data from Hutton et al (2006) is in US$.
[31] Using the population projections for each of the 20 countries in the subregion available at: http://www.un.org/esa/population/publications/wpp2006/WPP2006_Highlights_rev.pdf

- Identify a more realistic method of valuing labour time. To do this we note that approximately 50% of Malawi's national budget is donor-funded. Hence the value of local labour days is taken to be 50% of GNI per capita i.e. we halve the value used by Hutton et al. (2006).

Table 18: Indoor Air Pollution, Health-Related Economic Costs

BASE CASE (Using 50% of Hutton et al figures)	***US$***	***MK***
Annual health-related costs from indoor air pollution US$ - 2005 prices	17,837,364	
Annual health-related costs from indoor air pollution US$ - 2007 prices	**23,473,147**	**3,266,631,105**
As a share of GDP (2007)	0.66%	
Discounted cost over 10 years	96,248,289	13,394,354,682
As a share of GDP (2007)	2.70%	

From Table 18 we see that the base case estimate of annual health costs from indoor air pollution in Malawi was MK3.3 billion (US$23 million) at 2007 prices. This corresponds to a 0.66% share of GDP. Left unchecked over a period of 10 years the discounted cost (with a discount rate of 10%) was slightly more than four times as great – MK 13.3 billion (US$92.7 million).

2.4.4 Cost of Outdoor Air Pollution

This economic cost is grouped in the same Chapter of this report as Indoor Air pollution as it too results from particulate emissions. However, the World Bank 2002 estimates for PM10 health impacts are based on projected PM10 concentrations based on fuels used in cities with more than 100,000 inhabitants – wood fuel will be part of this mix in Malawi. The projections with limited information on the methodology used can be found in the World bank Little Green Data Book – see World Bank (2006). Further detail on the methodology used is given by Cohen et al (2002). Results are given in Table 19 below.

Table 19: Economic Costs of Outdoor Air Pollution – Based on World Bank 2002 data

	US$ million	***MK million***
Malawi's GDP in 2002 US$ current prices	2646	204,382
World Bank (2002) estimate of cost share of GDP	0.16%	0.16%
Implied costs of PM10 damage in 2002 prices	4.23	327.01

2.5 Interventions: Tackling Deforestation and Forest Degradation

2.5.1 Background

This section discussed interventions that could be invoked to tackle deforestation arising from the collection of firewood (for own use and sale) and the production of charcoal in the catchments to urban centres. As we saw in Table 16, excess demand for fuelwood in the urban areas was approximately 2.25 million cubic metres in 2008.

Looking forward, the 2009 Malawi Biomass Energy Strategy (BEST) Report concludes that not only will demand for fuelwood for cooking increase but that an increasing proportion of this demand will be met by charcoal production. Studies by the World Bank[32] and CIRAD[33] identify a strong link between urbanisation in Africa and increasing charcoal use and lend support to the BEST (2009) conclusions. Specifically:

- Even with a successful electrification programme there will be massive increases in charcoal demand over the next 15 years. ESCOM's ambitious electricity expansion plans over the next 15 years would lead to 42% of households in Lilongwe and 56% in Blantyre cooking with electricity as their principal fuel. There are various hurdles to be overcome to achieve this including significantly raising domestic electricity tariffs and meeting the priority electricity demands of industry and commerce but *even if they are*, the demand for charcoal will still double.

- Commercial firewood demand will also rise 39% over the next 15 years under the optimistic electrification scenario.

Their logical argument is that any strategy to address these conclusions will be based on three components:

1. Increasing the supply of sustainable woodfuels;
2. Increasing the efficiency of energy use; and
3. Creating the institutional capacity to manage the biomass energy sector effectively and implement the Strategy.

Given the focus of this Economic Study within the Malawi PEI we flag up the following issues.

2.5.2 Avoided Deforestation Projects – Forestry within the IGPWP

As Richards (2008) notes, within a national strategy for Reduced Emissions from Deforestation and Forest Degradation (REDD), avoided deforestation (AD) projects are designed to store carbon. In Malawi very few projects have been designed to meet the standards to secure carbon credits but there are a number of projects that aim to reduce deforestation and have lessons for future carbon sequestration projects.

The forestry component of the EU-funded Income Generating Public Works Programme (IGPWP) is particularly interesting as it aims to reduce poverty by increasing local production of fuelwood, timber and poles through planting community (forestry club) woodlots and planting on club members farms. After a successful three year first phase the programme has now entered a second phase with the target of planting 35,500,000 trees over a 5 year period[34]. This cost-benefit analysis uses data from the completed first phase of the project. Their method is summarised in Figure 3 below.

Using data from the IGPWP we estimate that with payments per project club member of around MK 1500 (US$10) over two years (incentives to raise seedlings and ensure the survival of trees planted out) the average club member plants 858 trees. After growing for 5 years this number of trees would supply a family of five with 2.5 years of fuelwood (if the trees grown are used solely for this purpose). As these trees coppice we can say the families involved will gain around 50% of their total fuelwood requirement for the rest of their lives – see Table 20.

[32] World Bank (2000), *Energy services for the world's poor*. Energy and Development Report 2000, Washington DC

[33] Quoted in Girard (2002), Charcoal production and use in Africa: what future?, Unasylva 211, Vol. 53, 2002

[34] http://www.pwp.co.mw/main.php?PageID=components&SectionID=forestry

Figure 3 : IGPWP Forestry Implementation Method

Forestry implementation method

1. April - May
Planning and meetings with District Assemblies, Traditional Authorities and others. Sensitization and selection of prospective villages

2. June - July
Committee/club training. Nursery construction

3. August - September
Distribution of inputs, pot filling.
Technical training.
Evaluation and payment for previous plantings (MK 5,000)

4. October
Seed sowing.
Nursery management training

5. November - December
Nursery management training.
Preparation for planting out.
Nursery evaluation and payment (MK 7,000)

6. January
Tree planting

7. March
Evaluation and payment for trees planted. (MK 5,000)

Source: http://www.pwp.co.mw/main.php?PageID=components&SectionID=forestry

Table 20: Estimated Average Fuelwood Supply from Two Years Planting: Malawi IGPWP

People/club	30
Number of clubs in phase 1	905
Average trees planted/club	25,732
Annual household requirement for trees @ 68 trees/person x HH size of 5	340
Estimated years of fuelwood supply for households of club members after tree felling at year 5	2.5

Source: derived from http://www.pwp.co.mw/main.php?PageID=components&SectionID=forestry

Data from rotational woodlot planting in the comparable Miombo eco-region of Tanzania indicates that households can generate a surplus supply of fuelwood by planting *Acacia crassicarpa* i.e. a five year rotation generates 7 – 16 years of fuelwood supply[35]. Hence, *if* IGPWP community members continue to develop woodlots in years 3-5 (after the project incentives and support finishes) they may also generate a fuelwood and timber surplus. Anecdotal evidence suggests that many if not most IGPWP beneficiaries do continue to plant trees in years 3-5, often on their farms[36]. Nonetheless, wood production in Malawi is likely to be lower than the levels reported in Tanzania as average land holdings are larger there (1.64 ha compared to 0.9 ha) and the tree species grown in the Tanzanian projects (*Acacia crassicarpa*) also appear to yield more biomass per hectare than the preferred species grown by IGPWP (*Senna siamea*). For the purpose of estimating conservative returns to this project we only take into account tree planting recorded by the project i.e. that undertaken in years 1 and 2 that provides 2.5 years of fuelwood supply.

[35] Sileshi et al (2007).
[36] Rose Bell, IGPWP Forestry Component manager, personal communication, Jan 2010

We know that forestry club member trees are used for firewood to provide poles for own use and sale. When home grown fuelwood is used, women in particular benefit from saving time in collecting fuel. Analysis undertaken by a World Bank team for Malawi's Poverty Assessment indicates that each day 1.5 hours are spent on fuelwood collection[37]. On the basis of survey work in three forest communities in Malawi, Fisher (2004) estimates the hourly return to low value farming activities as MK 2.96 in 2000 price. Updating this to 2008 prices, a day's labour (7 hours) is only valued at US$0.5. However, as 1.5 hours a day are saved on average for 913 days as result of the project, this amounts to a saving of US$80 spread across the five years after the trees are harvested at year 5.

The value of poles produced from communities involved in the IGPWP is recorded at MK 50/pole (US$0.43). Project records show an average of 858 trees per club member after two seasons which would be worth US$365 if sold for poles at year 5. If they survive the first two years, fast growing woodlot species such as *Senna siamea* are very likely to survive to year five. Moreover, as many project members continue to plant trees on their farms after programme incentives stop we are likely to have underestimated wood values to the individuals involved.

We do not have data on the proportion of trees used as poles or as firewood and so, for the purpose of this analysis we assume a 50:50 share. That is to say half of the benefits are valued using the low value of time saved from not having to collect firewood (US$80 over five years) and half are valued using the higher cash value from poles produced (US$ 365 over five years).

In addition to private benefits, tree planting with the IGPWP generates benefits for society. Firstly, carbon is sequestered *if* individuals would have cut existing forest for poles or woodfuel but now use their own renewable woodlots. Demonstrating that there is a genuine saving in carbon requires comparison of the "with project" situation against a baseline. This is a significant challenge requiring a separate study to establish the baseline and a credible verification methodology. Although the IGPWP does not attempt to do this, it is useful to consider the magnitude of income that it would generate for poor households if trees grown produced certified reductions in carbon emissions. To do this we use the results of Kimaro et al (2008) that indicate short-rotation *Senna siamea* in community run woodlots in a comparable area of Tanzania stores 11.5 tonnes of carbon (tC) per hectare in year. Sileshi et al (2007) find similar results for coppicing fallows in Zambia. Converting this to tCO2e with a value of US$6/ tCO2e implies a value of US$1.18 million for the stock of carbon in IGPWP trees at the end of year 5[38]. This would justify an annual payment of MK 17. 2 million (US$118,000) to project beneficiaries (equivalent to MK630 or US$4.3 per person per year) providing the wood grown prevented deforestation[39].

A number of the costs of unsustainable resource use can be linked to deforestation over an extended period of time. A case can therefore be made that afforestation will start to mitigate these impacts. As our focus was on trees planted for wood rather than nitrogen fixing species that improve soil fertility, we considered potential "off-site" benefits relating to:

[37] Bandyopadhyay et al (2006)

[38] Conversion factor and US$/tCO2 figures used by Plan Vivo – see Berry et al (2008)

[39] The aim is to illustrate the magnitude of carbon payments. We overstate potential payments to the extent that commercial schemes hold back a proportion of the carbon stored as security but this is probably outweighed by the very conservative estimate of wood grown by forestry club members. The critical assumption is that trees grown actually prevent deforestation.

- Lost hydro-electric generation
- Drinking water treatment costs
- Flood prevention

The relevant costs of unsustainable resource use (COURU) of type j for Malawi as a whole are shown in Table 42. As we did not know how deforestation in programme areas was related to the national COURU, we simply assumed a backwards looking, linear relationship. Thus to provide a *broad idea* of what this type of programme might contribute to mitigating these costs we calculated:

$B_j = COURU_j \times (\Delta HaF_p / \Delta HaF_{1991\text{-}2008})$ … 1)

Where:

ΔHaF_p = Change in hectares of forested land as a result of the programme

$\Delta HaF_{1991\text{-}2008}$ = Change in hectares of forested land between 1991 and 2008 for Malawi as a whole[40]

These crudely estimated social benefits from the IGPWP were rather modest, equating to a payment of approximately US$3.32/year per forestry club member. It suggested that on average the historical loss of forest is so great that afforestation makes a limited difference. However, any payment for environmental services would need to be based on primary research to understand the benefits of afforestation in a *particular* catchment.

We were fortunate to have accurate data from the IGPWP on phase 1 forestry component costs by year. These included staff costs, vehicle fuel and maintenance costs, procurement of inputs for the clubs and bonus payments and amount to MK 232 million (US$ 1.59 million) over three years.

Based on work in a number of forest clubs, the IGPWP estimated total labour requirement for club members over two years as follows:

Collection of fencing material	1 day
Fence construction	1 day
Collection of potting media	2 days
Pot filling	2 days
Seed sowing	1 day
Watering	1 hour every day for 12 weeks
Weeding	2 hours per week for 12 weeks
Root pruning	2 hours per fortnight for 12 weeks
Planting	2 days

Source: R. Bell, IGPWP, 2010

Combining these figures with the daily labour cost figures for farming activities from Fisher (2004) we imputed the value of time spent on project activities by club members. These were fairly substantial – MK1555 (US$13) over two years – and aggregated across all club members it was equal to 22% of the financial spend of the forestry component of the IGPWP[41].

Bringing together all the costs and benefits above allowed us to undertake a cost-benefit analysis from a national or international perspective. This is shown in Table 21 below. Government and

[40] Estimated by BEST (2009) as 669,000ha.

[41] This will underestimate total time spent as it excludes time spent in meetings but it is not clear what the value of leisure time forgone is in programme communities.

development partner discount rates are in the order of 10% and applying these over a 20 year time horizon the project was clearly economically viable with a positive net present value (NPV). In this case it is possible to calculate the internal rate of return to the project and we found it was around 62%. Hence, this appears to be an extremely good investment of public funds in a pro-poor project to improve the environment.

Table 21: Forestry IGPWP Economic CBA - All Costs & Benefits

	MK	*MK*	*MK*	*MK*	*MK*
Year	***Project costs***	***Own labour costs***	***Private benefits***	***Social benefits***	***Net benefit (all)***
1	39,798,360	21,113,252		19,850,556	-41,061,056
2	115,035,459	21,113,252		22,485,170	-113,663,542
3	76,899,921			25,119,783	-51,780,138
4				27,754,396	27,754,396
5			741,552,203	30,389,009	771,941,212
6		21,113,252		19,850,556	-1,262,696
7		21,113,252		22,485,170	1,371,917
8				25,119,783	25,119,783
9				27,754,396	27,754,396
10			741,552,203	30,389,009	771,941,212
11		21,113,252		19,850,556	-1,262,696
12		21,113,252		22,485,170	1,371,917
13				25,119,783	25,119,783
14				27,754,396	27,754,396
15			741,552,203	30,389,009	771,941,212
16		21,113,252		19,850,556	-1,262,696
17		21,113,252		22,485,170	1,371,917
18				25,119,783	25,119,783
19				27,754,396	27,754,396
20			741,552,203	30,389,009	771,941,212
NPV (10% discount rate)			972,373,211		
IRR			62%		

While this project intervention is a good use of public funds, it may not be financially attractive from the farmer's perspective. And if farmers do not see tree planting as being in their own interest it is very unlikely that this intervention will work. The financial analysis that follows differs from the economic CBA in three important respects:

Firstly, farmers only take into account the costs they bear i.e. labour costs. Secondly, the type of benefits we include are limited to financial benefits but these potentially range from wood values to wood values plus carbon payments. Specifically, we considered:

- The financial incentives actually paid by IGPWP for seedlings raised and surviving trees (approximately MK 860 per club member or US$ 6) in the first and second year of the project plus the financial benefits from selling poles or the time savings from reducing the amount of firewood collected by half (MK 27,313, US$233 per club member every 5 years[42]) - scenario 1.

[42] The timing of benefits is based on selling poles at year 5 rather than spreading out benefits between years 5 and 10. Given the very high discount rates used in the financial CBA this simplification makes no material difference.

- The carbon sequestration value of trees planted based on a 50% reduction in forest tree cutting for firewood by club members and US$6/tC02e (approximately MK 634 or US$4.3 per club member) paid each year plus the financial benefits from selling poles/time savings as above (MK 27,313, US$233 per club member every 5 years) – scenario 2.

- Only the financial benefits from selling poles or the time savings from reducing the amount of firewood collected by half – paid at year 5 – scenario 3.

Thirdly, the discount rate applied by farmers will be much higher than that used by government or development partners. Poor farmers typically cannot afford to wait for returns on their investment which explains why investments for farmers in Africa producing yearly returns of 150% or even 1200% may not be made[43]. Experimental data on subjective discount rates in Ugandan villages reported by Bauer and Chytilová (2009) indicate annual discount rates ranging from 320% – 460%. It can be argued that farmers giving up a limited amount of labour time to plant trees on marginal land are not risking much and so far lower discount rates should apply. Nonetheless, to provide a demanding test for this financial CBA we will assume a 400% discount rate.

The results of the financial CBA are given in Table 22 below.

Table 22: IGPWP Forestry Financial CBA Summary

	Net present value @ 400% discount rate	***Internal rate of return***
Scenario 1 – wood + current project payments	MK 757,653	>1000%
Scenario 2a – wood + regular annual carbon payments	MK -527,444	285%
Scenario 2b – wood + annual carbon payments x 1.5 in first three years and x 0.9 in remaining 17 years	MK 1,603,890	>1000%
Scenario 3 - wood only	MK -4,831,430	122%

The conclusions we drew from this were that:

1. Tree planting schemes that rely **only** on the financial returns from poles or time savings from producing wood fuel were not likely to be sufficiently attractive to get widespread uptake.
2. Adding carbon payments made things a lot more attractive from the farmer's perspective. However, while our figures on expected carbon payments were only indicative, they did suggest that regular annual payments might not be enough to encourage highly risk averse farmers to invest in tree planting. In this situation it would be necessary to make larger payments in the early years. By raising carbon payments by 50% in the first three years and compensating with a 10% reduction in years 4 – 20 the total payment was slightly reduced but it became much more attractive to farmers with high discount rates.
3. The IGPWP approach of providing incentive payments (of around US$6/club member) in each of the first two years made investing in tree planting financially attractive to poor farmers. We have already shown that it is economically viable from a national and international perspective. This is certainly an encouraging result although it is important to evaluate the

[43] Examples from the literature quoted by Bauer and Chytilová (2009).

programme to determine whether farmers continue to invest in subsequent five year periods where no incentive payments are made but returns have been demonstrated.

4. Tree planting within the IGPWP was roughly equally divided between communal planting and planting on individual farms. The contribution from individual farms was therefore significant and would probably become more important if the forestry component of IGPWP was introduced into areas that provided wood supply for the major towns in Malawi. Experience from Ethiopia is that in highly populated rural areas, private ownership of trees was more successful than community ownership[44]. The role of wood supply from individual farms is also likely to be critical in any programme for sustainable charcoal production (discussed in the sub-section below). We note here though that The Malawi Forestry Act 1997 allows for participatory forestry on customary land. The Act stipulates that this will be delivered by *community* forest management e.g. through village natural resource management committees. Hence it is important to consider whether the Act would preclude sustainably grown fuel wood from individual farms on customary land being sold for certified charcoal production.

2.7.2 Options and Payments for More Sustainable Charcoal Production

Given the very large forecast increase in the demand for charcoal in Malawi, any successful strategy for tackling deforestation will have to address how to produce charcoal from sustainably grown wood The current policy of banning charcoal has not only proved ineffective but encourages inefficient illicit charcoaling, produces incentives for corruption and deprives the Government of Malawi of useful tax revenue. As shown in Table 23 below, the estimated value of bribes paid on charcoal in 2008 was MK1.3 billion (US$9 million). Transferring these payments from the informal sector to formal taxes would produce revenue for environmental protection or other pro-poor expenditure.

Table 23: Current "Informal Taxes" Levied on Charcoal

	Values	***Sources***
Charcoal demand in 2008 (t)	305000	BEST (2009) Annex U
Final price in 2008 MK/t	28415	BEST (2009) Annex 1 Table 2
Proportion of price paid as a bribe	15%	Kambewa et al (2007) 12-20% range quoted
Annual value of bribes on charcoal paid (MK)	1,299,986,250	Derived from above
Annual value of bribes on charcoal paid US$	8,904,906	Derived from above

As set out in Malawi BEST (2009), "the underlying idea behind an increase in the sustainable supply of woodfuels is *professionalisation of the entire supply chain*, from local communities managing their natural resources and private farmers growing trees, via charcoalers who cut trees and make charcoal, to transporters who bring woodfuels to the market" p106. Senegal and Chad are identified as countries that have made significant advances in this area. Kenya and Tanzania have also started to develop and pilot interesting strategies in this area[45].

There are very significant challenges involved in establishing certified charcoal production in Malawi. These must not be understated but there is a great deal to play for. Not only are the economic costs

[44] Berhanu G., Pender J and G Tesfaye (2000), COMMUNITY NATURAL RESOURCE MANAGEMENT: THE CASE OF WOODLOTS IN NORTHERN ETHIOPIA, EPTD DISCUSSION PAPER NO. 60, IFPRI, Washington DC
[45] Garrett (2009)

of failing to act very high there may also be carbon payments available to support policy interventions. As Table 24 below shows, the *potential* value of avoided emissions from current annual charcoal production in Malawi is large – in the order of MK 2.5 Bn or US$17 million per year or US$55/tonne of charcoal.

Table 24: Potential Annual Value of Avoided Emissions from Charcoal

Charcoal demand in 2008 (t) - Best (2009)	305,000
Implied tonnes of roundwood to meet charcoal consumption at 20% conversion efficiency	1,525,000
Average tonnes of carbon per tonne roundwood - Girard (2002)	0.5
tC02e:tc	3.67
Implied tC02e from current charcoal consumption at 20% conversion efficiency	2,798,375
Implied tC02e per tonne charcoal produced	9.175
Voluntary market price for tC02e - Plan Vivo (2008) – US$/t	6
Potential revenue per tonne charcoal US$	55
Potential revenue per tonne charcoal MK	8,036
Total potential value of carbon payments for charcoal produced US$	16,790,250
Total potential value of carbon payments for charcoal produced MK$	2,451,131,387

In practice, there are a number of factors that will make it difficult to achieve this potential. Building and strengthening local institutions to enable certified production is likely to be the most challenging. These institutions will not only have to ensure that new sources of sustainable wood are used to produce charcoal but also that existing forest is not used. This latter issue is known as "leakage" – the wood that goes to produce charcoal may come from cutting established forest trees rather than trees grown sustainably for this purpose. This will require a large investment to build the institutional capacity to monitor and verify the supply chain from fuel wood production through to charcoal marketing. However, monitoring is easier if the government is attempting to regulate a small number of large "legal" charcoal producers. What we see at the moment though is that most charcoal producers operate at a very small scale and many are poor. Kambewa et al (2007) identify around 7,000 producers of less than 30 bags a month (42% of total production). Nearly 2000 medium scale producers supply a further 25% with 338 large scale producers contributing 33% of total production[46]. They note that "During the rains, households may turn to charcoal production as a coping mechanism against food insecurity: demand is high and prices are at their best". p12. This leads to a potential trade-off between having few, larger professional charcoal producers (with relatively low monitoring and enforcement costs) and many small-scale producers (with high costs of monitoring that only sustainable wood sources are being used). In the latter case, it may be possible to reduce monitoring costs by encouraging charcoal producers to form producer associations or cooperatives.

As building institutional capacity is difficult some may prefer technical solutions to increase the efficiency of charcoal production. For example, it has been argued that current recovery rates (wood–charcoal) of 10-15% can be increased to approximately 40% as a result of improved technology (kilns) and conversion techniques (drying, stacking, cooling)[47]. Yet BEST (2009) provide evidence that current charcoal production efficiency in Malawi is around 20%. We also know that large-scale relatively

[46] Kambewa et al (2007) p16, Op. cit.
[47] Garrett (2009)

capital intensive charcoal production is only an option for big charcoal producers that account for a third of production[48]. The benefits of improved charcoal kilns are therefore likely to reflect the cautious scenario in the Table below rather than the optimistic one. This result tells us that improved charcoal kilns can play a role in reducing the 2.25 million cubic metre excess demand in urban catchment areas but as they are likely to provide less than 15% of the excess demand, they will only be a small part of the solution. Tackling the problem of excess demand for charcoal will require a holistic solution to put in place efficient, professional, certified supply and to incentivize demand for this sustainable supply.

Table 25: Potential Impact of Improved Charcoal Kilns

Implied tonnes of roundwood to meet current charcoal consumption at 10% conversion efficiency	3,050,000
Implied tonnes of roundwood at 20% conversion efficiency	1,525,000
Implied tonnes of roundwood at 33% conversion efficiency	924,242
Implied tonnes of roundwood at 40% conversion efficiency	762,500
tC02e in 1 tonne wet wood	0.9
Cautious scenario	
Efficiency saving - 20%-33% efficiency gain (t)	600,758
Proportion of producers making saving	33%
Total saving of wet wood (t)	198,250
Total saving of tC02e	178,425
Optimistic scenario	
Efficiency saving - 10%-40% efficiency gain (t)	2,287,500
Proportion of producers making saving	80%
Total saving of wet wood (t)	1,830,000
Total saving of tC02e	1,647,000

2.5.3 Can Subsidised Electricity Solve the Unsustainable Charcoal Use Problem?

There is a strong case for rapid expansion of electrification in Malawi using hydro-electric generation on both economic and environmental grounds – see MCC (2009). However, even with optimistic assumptions on access, only a *minority* of urban households will cook with electricity over the next decade (BEST 2009, MCC 2009). Increasing domestic electrification can only slow the growth of unsustainable charcoal use (which will double rather than triple over the next 15 years[49])

Subsidising electricity consumption will not increase the rate of electrification (without switching supply from industrial and commercial sectors). Moreover, those with an electricity connection will make significant savings compared to those relying on charcoal or purchased fuelwood. Based on an average domestic consumption of 3285 kWh and a 2009 tariff of US$0.043/kwh substituting 883 kg of charcoal and 30 litres of paraffin will save the electrified urban consumer around US$105 a year[50]. Even at full cost tariffs (0.065/kWh) that ESCOM aspires to introduce in 2013, urban consumers will save around US$60 year.

[48] Kambewa et al (2007)
[49] Best (2009)
[50] Figures from BEST (2009) and MCC (2009)

We also know that non-farm urban consumers (those most likely to have access to electricity) are very unlikely to be poor - they constitute only 2.4% of poor households in Malawi[51]. From this data we can see that the current policy of subsidising electricity benefits the non-poor. In fact by taking scarce public funding from areas that matter a great deal to the poor such as health, education and environmental protection, these subsidies damage the interests of the poor. It doesn't make sense on environmental grounds either as even at full economic cost, households with access to electricity have an incentive to use it, save money and reduce their charcoal, firewood and paraffin consumption.

Nonetheless, getting a connection to the electricity grid costs US$175 which is a significant cost even for average (non-poor) urban households. This would be best dealt with by ESCOM spreading connection costs over a number of years or from savings clubs or micro-finance schemes rather than State subsidies.

2.6 Forestry Sub-Sector Policies, Projects and Data

Detailed additional information relating to forestry resources is presented in three annexes to this report, as follows:

Annex 2: The Legal and Regulatory Environment.
Annex 3: Forestry Sub-Sector Programmes/Project
Annex 4: Status of Forestry Sector Data

2.7 Recommendations

From the foregoing analysis, the study makes the following recommendations:

1 Government should undertake an ex-post evaluation to see if IGPWP forestry clubs have maintained (coppiced) woodlot trees and identify the additional post-project intervention planting undertaken.

2 Subject to confirmation of the above, there is need to support a significant expansion of the forestry component of the IGPWP. There should be a particular focus on the fuel wood catchments of the main urban centres. Consideration should be given to developing this within the national REDD programme, recognising that this would be one component among many and that lack of national capacity may delay implementation.

3 Government should draw on best practice in other African countries to design a system for certified charcoal supply. This should be piloted as soon as possible.

4 Forestry stock level data is out of date and a national study is needed to bring this up to date.

5 The national income accounting system should be improved to capture reliable information about the sector's contribution to the economy, and its overall socio-economic significance.

6 Government should facilitate the management and sustainable utilisation of forestry resources by providing adequate budgetary resources to deliver agreed outputs.

[51] Agricultural Growth and Investment Options for Poverty Reduction in Malawi, 2008 reprinted as Annex 14 MCC (2009)

7 Future versions of the Annual Economic Report should provide detailed and up-to-date information to inform decision-making, including data on stock levels, trees planted, and fire incidences. In addition, the report should ensure that figures are revised each year.

8 Government should enhance the usefulness of the State of Malawi Forests 2004 report by ensuring that:

a) the data on sizes and ownership of forest resources are available for all types of resources in all the districts;
b) the presentation of the data is standardised for all the districts;
c) the document is frequently updated; and
d) the data is summarised in form of one or a few country tables.

3. Fisheries Resources


A: Chambo fish from Lake Malawi


B: A typical Malawi delicacy with fish

A: From fhsbandawe.org.uk/.../malawian-food as at 27/01/11
B: From chinatsua.files.worldpress.com as at 27/01/11

Fisheries resources contribute to the livelihoods of more than 1.6 million Malawians. Almost 60,000 people are employed as fishers, and about 350,000 are engaged in fisheries-related economic activities. The fisheries sub-sector contributes around 4.0% of Malawi's GDP, but this would be at least 0.8% higher if improved fishing practices and post-degradation recovery in catch for Lake Malawi's artisanal fisheries was replicated throughout the country. Fish used to be the most affordable source of animal protein in Malawi. However, increasing population, overfishing, dwindling in catches as well as rising real fish prices have reduced per capita fish consumption from 9.4 kg to 5.4 kg between 1990 and 2008.

3.1 Characteristics of Fisheries Resources

In Malawi, the fisheries sub-sector is categorised into three groups: capture fishery, aquaculture and aquarium trade. Capture fishery involves fish exploitation from the naturally existing water bodies while, in aquaculture, fish is artificially cultured in various water impoundments. Aquarium trade is where fish species of both local and international scholarly and ornamental importance are the centre of focus.

3.1.1 Capture Fishery

The capture fisheries category is divided into three enterprise types, based on scale of investment and operation: small-scale commercial, semi-industrial and industrial enterprises. While industrial enterprises are predominantly a Southern Region phenomenon, small-scale (artisanal) activities are spread over the entire stretch of the country. Due to lack of investments and controlled entry into the industry through licensing, activities in the industrial sub-sector have not changed much over the years, such that the sub-sector's output has remained largely static for over a decade. On the other hand, changes have been experienced in the semi-industrial and small-scale enterprises in the form of entry of new players and new or enhanced policy initiatives. The responses of players to demand and supply have affected the output of these enterprises.

According to the government (GoM, 2008; 2009), Malawi's traditional (capture) fish catch is composed of 18 main species dominated by *Engraulicypris sardella* (usipa), *Copadichromis virginalis* and relatives (utaka) and *Lethrinops spp*. and Allied genera (kambuzi). These species respectively accounted for 32.5%, 16.9% and 12.4% of about 71, 000 total metric tonnes of fish caught in 2008. Other important species include *Bathyclarias spp*. and *Claria spp*. (mlamba), *Oreochromis* (chambo), *Buccochromis spp.* and Allied genera (mbamba), *Oreochromis shiranus* and relatives (makumba), and *Barbus paludionosus* and relatives (matemba). However, Lake Malawi alone has been reported to have 240 identified species with an estimated 500 awaiting taxonomic identification.

Table 26 provides a summary of the catches for 2007 and 2008. One striking feature of the data in this table is that the percentages of total catch attributable to each of the species are fixed across the two years, indicating that these data are crude approximations. Moreover, the data include imputed values traded by small-scale enterprises, but do not include catches for own-consumption.

Although not accounting for a significant proportion of the total catch, chambo (*Tilapia rendalli, Oreochromis karongae and Oreochromis shiranus*) is considered to be one of the most important and popular species due to its great taste, high nutritional value and export potential.

Table 26: Fish Catches by Species in 2007 and 2008

Species	***Local Name***	***Catch (metric tonnes)***		***% of Total Catch***	
		2007	***2008***	***2007***	***2008***
Engraulicypris sardella	Usipa	21,230	23,207	32.56	32.56
Copadichromis virginalis and relatives	Utaka	10,999	12,023	16.87	16.87
Lethrinops spp. and Allied genera	Kambuzi	8,145	8,904	12.49	12.49
Bathyclarias spp. and *Claria* spp.	Mlamba	3,738	4,086	5.73	5.73
Oreochromis spp	Chambo	3,280	3,586	5.03	5.03
Buccochromis spp. and Allied genera	Mbaba	2,336	2,553	3.58	3.58
Oreochromis shiranus and relatives	Makumba	2,158	2,359	3.31	3.51
Barbus paludionosus and relatives	Matemba	1,930	2,110	2.96	2.96
Others		11,381	12,438	17.46	17.46
Total		***65,197***	***71,266***	***100.00***	***100.00***

Sources: GoM (2008, 2009).

According to GoM (2007, 2008) Lake Malawi is the most important resource, accounting for over 82% of the total catch in 2007. The other key resources are Lake Chilwa (9%) and the Shire River (7%). As with the data on fish catches shown in Table 26, the percentage distribution of the fish catches across water bodies in 2008 is reported to be exactly the same as in 2007 (GoM, 2008; 2009).

3.1.2 Aquaculture

The key stakeholders involved in aquaculture include entrepreneurs such as MALDECO Fisheries, local farmers, local fishers, fish farmers' organisations (such as Innovative Fish Farmers Network and Farmers Union of Malawi), input suppliers (such as Blantyre Netting Company), and fish traders.

Additional key stakeholders are government agencies, non-governmental organisations (NGOs, such as Concern Universal and World Vision), as well as research, training and education institutions (such as the University of Malawi, Mzuzu University and Mpwepwe Fisheries). Other key stakeholders are credit and finance institutions (such as Savings and Credit Cooperatives (SACCO) and the Malawi Rural Finance Company (MRFC)). There are also some development partners involved in aquaculture, including the European Union (EU), the Japanese International Cooperation Agency (JICA), the Canadian International Development Agency (CIDA) and the Icelandic International Development Agency (ICEIDA).

Although other species are also cultured, Chambo is the main specie raised in the aquaculture category. A limited amount of trout farming occurs on Zomba Plateau and a few other places. While the output of cultured species, valued at US$ 1.4 million in 2008, has grown by 52% over the period 2000 - 2008, it still only contributes about 2% of total fish production (GoM, 2009), and is very far from meeting the excess demand for fish. Box 2 presents some research findings on aquaculture farming in Malawi.

Box 2: World-Fish Centre Research Findings

According to the Zomba-based World Fish Centre, inclusion of aquaculture farming within the integrated farming system has improved farm profitability by 28%, while fish consumption by the fish farmers has gone up by 163% translating to a 23% rise in protein consumption by the same population. On average, it costs US$940 in fixed costs before depreciation and an average of US$108 in operating costs in each cycle to produce small scale pond fish, estimated at an average of 9,800 pieces of fingerlings, from about 2,300 square meters of farming area. The fish are often sold within the farming area, distributed for free or consumed by owners. There is no standard price for selling fish amongst the farmers, there are variations associated with geographical locations and choice between selling fish in single pieces or by weight. Minimum prices have been observed by this study at around MK76 (US$0.54) per piece or MK250 (US$1.79) per kilogram. Production has been reported to be heavily reliant on environmental conditions including a sustainable availability of fresh water from streams. Considering that farming practices occur as an integrated process, loss of proteins due to scarcity of fish is often covered by consumption of mainly poultry and occasionally supplemented with other animal products found on the farms (WFC, 2005).

3.1.3 Aquarium trade

Lake Malawi alone has over 800 endemic fish species which are of both local and international scholarly importance and also act as a source of tourism attraction. Some fish species such as mbuna are exported to other countries, hence contributing to the generation of foreign exchange. Some of the fish species under aquarium trade are of ornamental importance (GoM, 2008)

3.2 Significance of Fisheries Resources

The socio-economic importance of fisheries resources to the national economy, and the threats arising from over-fishing and dwindling stocks, are relatively well-documented. Fisheries resources are a key source of employment, protein, income, foreign exchange and bio-diversity. More broadly, at official retail prices, the annual total catch was worth MK9.4 billion (US$67.1 million) in 2008. In terms of value, fish landings in 2007 were estimated at MK7.6 billion or US$54.3 million (GoM, 2008), most of which was domestically consumed. The GoM estimates that the Fisheries sub-sector alone accounts for about 4%GDP (GoM, 2008).

Fish used to be the most affordable source of animal protein in Malawi up to the early 1990s, but rising costs, overfishing, decreasing supply, increasing population and increasing fish exports have reduced domestic per capita fish consumption from 9.4 kg to 5.4 kg per annum between 1990 and 2008. The World Health Organisation (WHO) recommends an average per capita annual consumption of 13kg to 15kg (GoM, 2009). In addition to vitamins and minerals, the significance of fish as a key protein source among Malawians (especially rural communities) is well-recognised. Mkoko (1992) reported that fish accounted for over 60% of dietary protein intake, and 40% of the total protein supply in Malawi. Horn (1987), as cited in GoM (2008), also reported these estimates, adding that fish constituted 70% of animal protein intake, largely because it was cheaper than its close substitutes (mostly meat) during the 1990s. No known studies have been conducted to explicitly compute the cost of the reduction in per capita fish consumption on the poor, or the cost of replacement protein. To do this requires a tailor-made household consumption assessment, which is beyond the scope of this study.

In responding to growing demand for fish consumption, there have been growing efforts to invest in fish farming as an integral part of the routine agricultural activities that households engage in, thereby further speeding up the declining trend in fish resources. The overriding implication is that the declining fisheries resources in the natural water bodies are putting pressure on the households to pursue alternatives that take more time and money to grow like livestock production.

The fisheries industry is also a source of employment. The Department of Fisheries reports that the industry directly employs about 60,000 fishers and indirectly engages 350,000 people through fish processing, transportation, marketing, as well as boat building and repairs. In total, it is estimated that the industry supports about 1.6 million people in the lakeshore areas[52]. Additional income arises from the sale of ornamental fish (hence biodiversity) and from tourism (such as visitors to Cape Maclear and Lake Malawi National Park). In addition to being the main source of these direct benefits, Lake Malawi is a rich natural resource of interest among researchers, because it is known to stock over 800 fish species, although only 240 of these species are clearly identified (GoM, 2008). However, no information on the monetary values of these activities is currently available.

3.3 Trends in Fish Catches

Between the beginning of the 1990s and the end of that decade, official fish production estimates went down from about 70,000 metric tonnes to about 50,000 metric tonnes per year (see Figure 4 and Table 28 below). Moreover, Malawi experienced an annual decline of about 9,000 tonnes of Chambo fish production between 1980 and 2000 (GoM, 2004). Declining stocks due to over-fishing, weak enforcement of regulations and absence of clear property rights have been cited as some of the factors responsible for the decline in total catches (GoM, 2008). However, recent figures indicate an upward trend in the total landings, an issue that is discussed below.

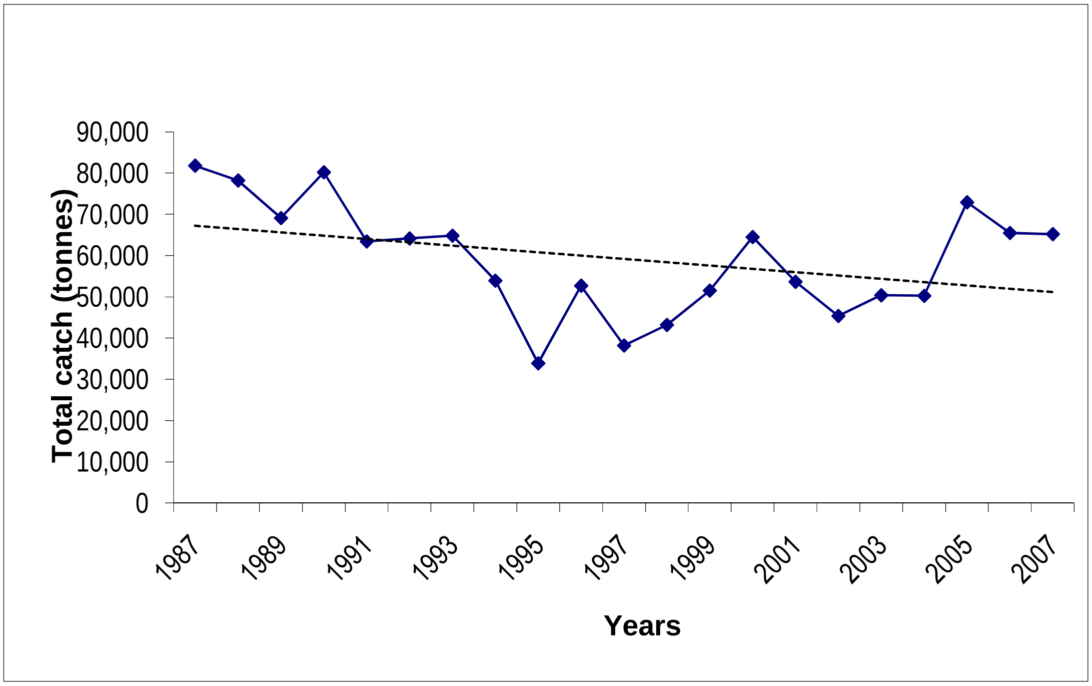
While the number of fishers has increased from about 10,000 in 1991 to above 60,000 in 2008, the annual supply of fish per person has fallen from 9.4 kg to 5.4 kg during the same period (Campbell and

52 These figures may require revision as they have been static for several years (see GoM, 2008; 2009).

Townsley, 1996; GoM, 2008)[53] due to many factors, including the exporting of fish to neighbouring countries. This suggests that supply has not kept pace with demand for fish, and in part reflects the direct effect of population growth. If this alarming rate of decline in per capita fish supply (which is at an estimated loss of 0.24 kg per year) remains unchecked, and assuming that capture fisheries is the only source of fish, fish supply would decline to zero within the next 23 years.

Figure 4 shows the trend in fish catches over the period 1987-2007. As shown, average total catch had been on the decline over this period from a high of just above 81,000 tonnes in 1987 reaching the lowest level of 33,895 in 1995.

Figure 4: Total Fish Catch (Tonnes)



An analysis of the data shows that the downward trend in the artisanal catch from Lake Malawi turns upwards after 1995, but the trend continues downwards or remains at depressed levels for all the other key water bodies. A number of factors are involved in explaining these trends including the following:

- *Declining stocks due to over-fishing in shallow waters.* For example, studies of the Lake Malombe and South West arm of Lake Malawi fisheries by Van Zalinge *et al.*(1992) show that the maximum sustainable yields of these two water bodies were well exceeded by the early 1980s. Bioeconomic models prepared as part of these studies predicted declining profitability and increasing effort for those involved in artisanal fishing if practices used in the early 1990s were continued. This is confirmed by the commercial sector. The MALDECO Fisheries Company, the largest commercial fisheries institution, has had to extend its activities to deeper waters within Mangochi due to over-exploitation of their traditional shallow sites. This suggests that fishing practices are becoming too sophisticated for ordinary fishermen to cope.

53 In 1976, annual per capita fish consumption was as high as 12.9 kg.

- *Weak institutions* for the enforcement of regulations in one respect and a complete *absence of clear property rights* in some other cases, thus exacerbating overexploitation of the fisheries resources that are within easy reach of the fishers.

- *A decline in the number of fishermen and equipment* operating in the Malawian fishing industry during 1998 – 1999, as a result of cost pressures and increased effort required per catch. For example the Malawi Government reported a reduction in the number of boats with engines from 3,818 cc to 3,622 cc during this period, on account of high fuel and maintenance costs, as well as the declining profitability of fishing, as noted above.

- The trend is also due to a significant decline in fish catch from Lake Chilwa from as high as 10,186 tonnes in 1994 to 1,069 tonnes in 1997. This decline was as a result of the drying up of Lake Chilwa in 1995 following a drought that hit the country in the previous two years.

- *A subsequent significant jump of 79% in the number of gill nets* between 1999 and 2003. Together with corresponding increases of 15% and 20% in the population of fishermen and their assistants, respectively, this contributed to the observed increase in production levels. Gill nets (and fish traps) are the most important fishing equipment used in Malawi. In order to ensure that too small fish are retained in the waters for breeding, the Fisheries Department has rules that regulate the types of gill nets that can be used. However, enforcement is sometimes a problem, largely due to resource limitations faced by the department.

- *A signalling effect of the significant jump in the retail price since 2000.* From 2000, there was a clear rise in fish prices, reflecting the scarcity of fish. The average price subsequently increased from MK52/kg (US$0.54/kg) in 2003 to MK97/kg (US$0.89/kg) in 2004, and to MK116/kg (US$0.83) by 2007. The attractiveness of fish sales consequently led to the increase in fishing effort that landed more quantities in 2005 through 2007.

- *Policy initiatives started impacting positively on production levels from 2001*. For example, the National Fisheries and Aquaculture Policy which came into effect in 2001 might have contributed to the growth of the industry. A full discussion of the policy environment and related strategic initiatives for the fisheries sub-sector are discussed in Annex 5.

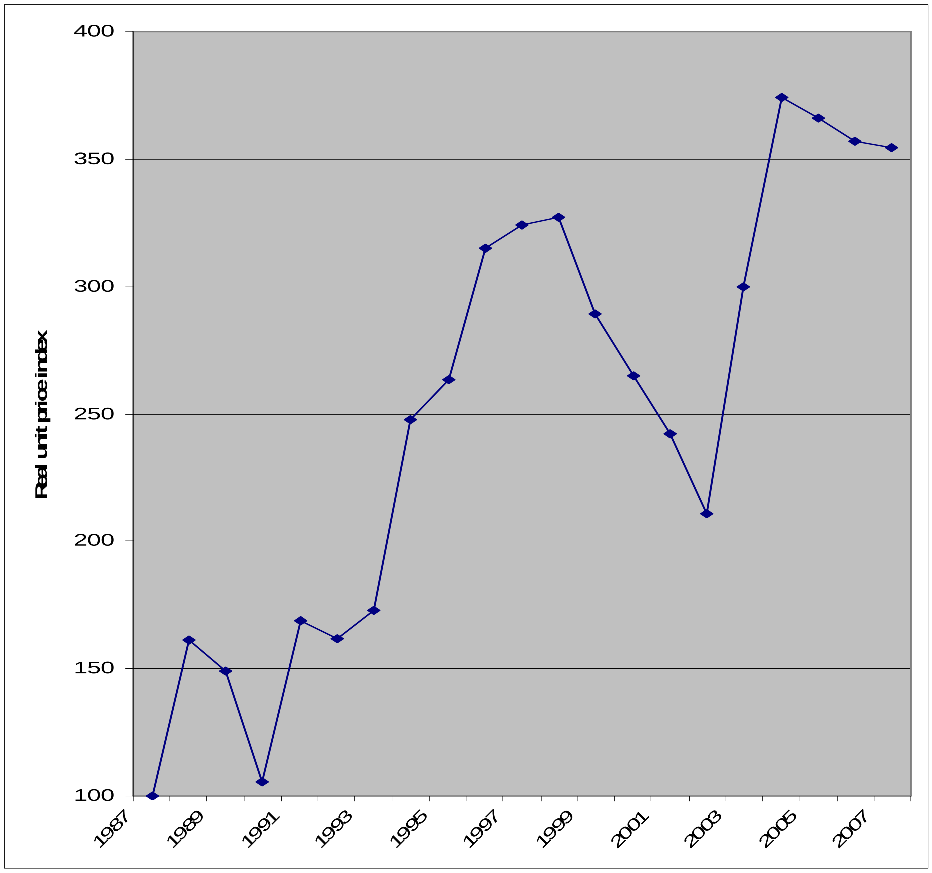
Human population growth has played a key role in driving the demand for fish in Malawi. Declining supplies over much of the past two decades have resulted in a significant increase in the real prices of fish and a decrease in per-capita fish consumption. While the fish catch has fallen by 20% during 1987 – 2007, data from NSO suggests that the country's human population has risen by about 61% from 7.9 million to 12.7 million over this same period. Hence, population growth and a decline in fishery resource due to over fishing are likely to be much more important factors in explaining declining per-capita fish consumption than the declining total catch.

The real price of fish is the result of demand pull factors (increasing population, increasing real incomes, changing tastes) and cost push factors (declining supplies of fish, increases in real input costs for fishing). Figure 5 shows real fish prices - that is, reported beach price reported deflated by the annual consumer price index - calculated for 1987 – 2007. This reveals that fish was around 3.5 times as expensive in real terms (after allowing for general inflation) in 2007 as it was in 1987.

The second source of fish supply in Malawi is cultured species, especially those produced in fish ponds. It is clear from

Table 27 below that, on average, production levels for all the important cultured species that the government has been promoting (as discussed below) have been on the increase. Yet, as cultured fish production currently provides less than 2% of total fish production in Malawi[54], it cannot substitute for the decline in fish catches. Recent cage culture initiatives by MALDECO Fisheries suggest that there is potential that the contribution of cultured fish production could improve. The MALDECO cages produced about 620 tonnes of chambo between January and December 2009, which was sold at an average price of MK400 per kilogram.

Figure 5: Trend in Real Fish Prices (1987=100)



[54] Based on the 2008 figure for cultured fish production

Table 27: Production Levels (Tonnes) and Estimated Value (US$) of Cultured Species

Species	Estimated Units	Year 1997	1998	1999	2000	2001	2002	2003	2008
Cyprinus carpio	Production	25	10	8	10	10	8	4	30
	Value	15000	10000	8000	10000	10000	8960	5600	42000
Oreochromis shiranus & related	Production	190	270	565	500	600	670	680	850
	Value	309100	309100	565000	550000	575000	649600	696000	869550
Tilapia rendalli	Production	0	0	-	-	12	70	85	230
	Value	0	0	-	-	13800	11200	42000	113647
Clarias gariepinus	Production	47	30	12	15	18	10	17	42
	Value	7700	12000	14500	18000	18000	11200	17000	42000
Oncorhynchus mykiss	Production	-	-	5	5	8	4	15	48
	Value	-	-	20000	17500	57200	24800	96000	307200
Total production		262	310	590	530	648	752	801	1200
Total value		331800	331100	607400	595500	674000	705760	856600	1374397

Source: GOM (2008).

Pond farming appears to have become more of an upland venture; most people living along the natural waters still depend on fish resources from the lakes and rivers. Consultations with fisheries specialists have also revealed that populations found along the lake do not engage much into fish farming, and are usually the first to suffer from protein loss when fish catches decline because urban markets are preferred during such periods. The experience of MALDECO Fisheries in advanced cage culture indicates that small farmers would not be able to meet the costs and sustain cage culture built on imported materials. Promotion of cage culture that uses locally found materials such as bamboo floaters would be a suitable option for small scale farmers earning a living along the lakes and rivers.

Despite the strides taken in aquaculture production, the aquaculture policy restricts the use of exotic species such as carp. Carp has shown to grow fast and adapt fast to aquaculture production in other countries. However, the neighbouring countries with which Malawi shares some water bodies culture them. It is imperative that such restrictive policies (including the use of hormones in fish production) be reviewed.

Table 28 gives the trends observed in small scale fish farming in rural Malawi between 2003 and 2008. The growth rate for ponds is 5% over this period, depicting an average growth rate of 1% per annum. The Malawi Government attributes this rise to the increase in the price of fish on the market (GoM, 2008). Additionally, during this period, the HIPC Initiative and NGOs (e.g., World Vision International and Concern Universal) promoted fish farming by supporting small farmers in pond construction and fingerling distribution.

Table 28: Distribution of Small Scale Farmers and Ponds by Region

Region	No. of farmers		No. of ponds	
	2003	2008	2003	2008
South	1972	2400	3500	3750
Central	922	1550	2900	3100
Northern	1517	2050	3100	3150
Total	4411	6000	9500	10000

Source: (GOM, 2008).

3.4 Cost of Unsustainable Fisheries Resource Use

In order to estimate the cost of unsustainable fisheries, ideally bio economic models for each water body derived from scientific estimates of maximum sustainable yields are used. The annual cost of current fishing relative to the maximum sustainable yield are compared. As these models were not available, indicative lower-bound estimates based on the following were used:

- Policy interventions and related activities (see Annex 5) have had a particular focus on artisanal fishing in Lake Malawi (e.g. National Fisheries and Aquaculture Policy) and, as a consequence, by 2007 the artisanal fish catch from Lake Malawi had recovered - reaching approximately 120% of the 1987 level having fallen to 50% of this level in 1995. This provides an indication of how fish catches could recover in future if behaviour is changed now. It is a lower bound because the first policy interventions in the area involve a lot of new learning and will necessarily be imperfect. As a result the level of future gains will be lower than that predicted by bioeconomic models.

- The catch from each of the other water bodies as well as the Lake Malawi (LM) commercial fishery realisable if it had followed the same pattern as the Lake Malawi artisanal fishery was calculated. This implies restricting catches in the middle of the period so that later catches recover.

- The study further calculated the difference between actual and projected yields for each fishery, for each year to 2007. Note that this was negative for three years, as restraint lowered total catches. The annual difference was valued at 2007 prices.

- The discounted present value of the annual difference was estimated using a discount rate of 10%. This captured the value of future changes in revenues from fishing from a change in policy today with values in the future years worth successively less than current values.

These steps are shown in

Table 29 and Table 30 below. As a lower bound we took the value of the difference between actual and projected yield in 2007 as indicative of the value we could expect each year going forward if sustainable fisheries resource use was followed as outlined in National Fisheries and Aquaculture Policy. However, a case can also be made for assessing the damage caused by using the discounted stream of annual differences over the 20 year period. Using the lower bound estimate, the annual cost of unsustainable fishery use was MK 3.9 Billion (US$27 Million) in 2007, equivalent to 0.8% of GDP assuming fisheries contribute 4% GDP (

Table 31). The discounted value of lost fishery production was MK 7.7 Billion (US$55 million), 1.5% of 2007 GDP.

Table 29: Fish Catches under Alternative Practice

If same pattern as Lake Malawi Artisanal							New	Additional
Year	L. Malawi - Artisanal (tonnes)	L. Malawi Commer. (tonnes)	L. Malombe (tonnes)	L. Chilwa (tonnes)	L. Chiuta (tonnes)	Lower & Middle Shire (tonnes)	TOTAL (tonnes)	Total catch (tonnes)
1987	41,800	8,200	13,000	8,400	3,300	7,100	81,800	0
1988	40,400	7,925	12,565	8,119	3,189	6,862	79,060	860
1989	33,800	6,631	10,512	6,792	2,668	5,741	66,144	-2,956
1990	31,600	6,199	9,828	6,350	2,495	5,367	61,839	-18,361
1991	30,000	5,885	9,330	6,029	2,368	5,096	58,708	-4,717
1992	35,500	6,964	11,041	7,134	2,803	6,030	69,471	5,325
1993	38,200	7,494	11,880	7,677	3,016	6,489	74,755	9,933
1994	29,461	5,779	9,163	5,920	2,326	5,004	57,653	3,736
1995	21,470	4,212	6,677	4,315	1,695	3,647	42,015	8,120
1996	36,716	7,203	11,419	7,378	2,899	6,236	71,851	19,156
1997	31,192	6,119	9,701	6,268	2,463	5,298	61,041	22,826
1998	31,037	6,089	9,653	6,237	2,450	5,272	60,737	17,539
1999	30,943	6,070	9,623	6,218	2,443	5,256	60,554	9,042
2000	44,775	8,784	13,925	8,998	3,535	7,605	87,622	23,133
2001	37,603	7,377	11,695	7,557	2,969	6,387	73,587	19,944
2002	32,038	6,285	9,964	6,438	2,529	5,442	62,696	17,327
2003	36,730	7,205	11,423	7,381	2,900	6,239	71,878	21,496
2004	36,610	7,182	11,386	7,357	2,890	6,218	71,643	21,403
2005	58,859	11,547	18,305	11,828	4,647	9,998	115,183	42,270
2006	51,796	10,161	16,109	10,409	4,089	8,798	101,362	35,878
2007	50,527	9,912	15,714	10,154	3,989	8,582	98,878	33,678

Table 30: Estimated Values of Change in Fishing Practice

Year	*Additional Value (MK'000)*	*Additional Value in 2007 prices (MK'000)*	*Additional Value in 2007 prices US$000*	*Discounted Value in 2007 prices (MK'000)*	*Discounted Value in 2007 prices US$000*
1987	0	0	0	0	
1988	2,611	156,625	1,125	142,386	1,023
1989	-3,263	-149,443	-1,074	-123,507	-887
1990	-14,910	-588,660	-4,230	-442,269	-3,178
1991	-6,438	-227,167	-1,632	-155,158	-1,115
1992	7,988	250,166	1,798	155,333	1,116
1993	20,089	508,943	3,657	287,285	2,064
1994	14,945	307,049	2,206	157,565	1,132
1995	48,723	746,877	5,367	348,423	2,504
1996	270,105	2,256,333	16,213	956,906	6,876
1997	482,923	2,865,452	20,590	1,104,756	7,938
1998	415,541	2,257,530	16,222	791,250	5,686
1999	197,363	826,503	5,939	263,349	1,892
2000	507,034	1,455,826	10,461	421,701	3,030
2001	564,286	1,251,337	8,992	329,516	2,368
2002	449,275	809,990	5,820	193,905	1,393
2003	1,135,403	1,783,242	12,814	388,085	2,789
2004	2,077,417	2,978,072	21,400	589,196	4,234
2005	4,142,499	5,451,338	39,172	980,471	7,045
2006	3,731,265	4,254,793	30,574	695,693	4,999
2007	3,906,671	3,906,671	28,072	580,702	4,173
Total	17,949,527	31,101,476	223,487	7,665,589	55,083

Table 31: Estimated Cost of Unsustainable Fishing

	MK000	*US$000*
Economic cost = value forgone in one year (07)	3,906,671	28,072
2007 cost as a share of GDP	0.8%	0.8%
Discounted value	7,665,589	55,083
Discounted value as a share of GDP	1.5%	1.5%

3.5 Interventions and associated cost-benefit analysis

3.5.1 Capture Fisheries

Investment in building institutional capacity to strengthen implementation of the policy and reduced rate of degradation described in Annex 5 is a key requirement for the fisheries sub-sector. The evidence we have presented on the economic cost of unsustainable fishing and water resource environmental degradation (

Table 31) indicates that at least MK 3.9 billion (US$28 million), or 0.8% of GDP in 2007, is lost each year in Malawi. Hence, the potential returns to interventions in this area are significant. If the Fisheries Department were to produce specific proposals on how investment in improved monitoring of other activities as well as how restoration of the degraded environment is likely to reduce unsustainable fishing, it would be relatively straightforward to assess economic costs against likely economic benefits. Currently, however, there is insufficient data to undertake such an assessment.

3.5.2 Aquaculture

Data does exist on an interesting pro-poor intervention in the aquaculture area. This is an evaluation by Dey et al (2006) of the impact of development and dissemination of integrated aquaculture-agriculture (IAA) technologies in Malawi. With this system, existing resources (in the form of organic wastes and byproducts) from the farm are utilized as much as possible as nutrient inputs in ponds. This WorldFish Centre project also used an innovative "farmer participatory research" approach to technology transfer. Data for this evaluation came from a survey of 360 households in six sites in Malawi covering both IAA-adopting and non-adopting farmers. Dey *et al* (2006) summarise the key findings in terms of on-farm impact from IAA as in Box 3 below. In economic terms the project has been a success. Taking all the project costs into account, it is estimated to have produced a benefit-cost ratio of 1.4 over the period 1986 – 2001 with an internal rate of return of 15%. Box 3 indicates that it has also made financial sense for households adopting IAA as the returns to labour from aquaculture are higher than the returns obtained from supplementary off-farm work by households in control groups. This suggests that there is scope for further expansion of the IAA model in Malawi. However as the success of the project reflects at least in part the technique for disseminating findings any scaling up of the project should also use the same dissemination techniques.

Box 3 summary of farm level impacts of IAA adoption in Malawi

- IAA farmers grow more high value crops (e.g. vegetables) around their fish ponds
- Total factor productivity of IAA adopters exceeds those of non-adopters by 11 percent
- Labour input of IAA adopters exceeds those of non-adopters by 25 percent
- Average farm profits per unit area owned by IAA adopters are more than double those of non-adopters.
- Net farm income of IAA adopters exceeds those of non-adopters by 60 percent
- Fish accounts for slightly more than 10 percent of the net farm income of IAA adopters
- An increase of 1 percent in the probability of IAA adoption increases net farm income per ha by 0.9 percent
- Farm size has a negative correlation with net farm income per ha positive correlation with the IAA adoption decision i.e., larger farmers are more likely to adopt IAA
- IAA adopters are technically more efficient than non adopters
- IAA adopters consume more animal protein than non-adopters
- No significant impact of IAA adoption on nutritional status of children below five years could be demonstrated. However, this may be shown in the longer term
- Case studies revealed that IAA reduces nitrogen loss, increases nitrogen use efficiency and has a positive effect on sustainability

Source: Dey *et al* (2006)

3.6 Information Gaps, Action Points and Conclusions

The NAPA for climate change on fisheries was finalised in 2004 by a team of consultants to guide preparedness initiatives for responding to climatic effects. Effects of droughts, flooding and agricultural performance on fisheries and the fish industry are some of the key aspects highlighted in the NAPA. The plan lists a number of reports that reflect on the effects of climatic change on fish resources and the changing terrain in the fishing industry. The analyses being referred to date back to 1992, and the latest report being cited was done in 2001. Until 2007 the need to firm up sustainable methods of utilizing the fisheries and related lake shore resources in Malawi was still being documented at an abstract level. The NAPA concedes that very few studies have been undertaken in the area of fisheries, particularly to analyse the adverse effects of climatic changes. In this respect, Msiska (2009) recently noted that:

> "The capacity to study the "resource responses" is low in Malawi. So far studies undertaken to understand the effects of climate change on fisheries have been anecdotal and no time series exist. Some of the bio-physical and chemical nutrient responses require modeling to be studied. Such skills are in short supply in Malawi and there is need for specific training targeting methodological aspects in the sector".

Prior to the preparation of the NAPA, the Initial National Communication under the UNCCC of 2003 made the following observations with respect to the effects of climate change on fisheries, based on the prior analyses already referred to (see GoM, INC, 2003):

- Fish resources would be adversely affected by projected droughts, low rainfall over Lake Malawi, and increases in water weeds, water hyacinth, and azolla, as well as sediment and nutrient loadings; and
- There could be no adverse effects arising from projected temperature increases and projected increase in wind speed over Lake Malawi.

Besides, gaps at the policy level have also been identified. For example, the need to rationalize a public-private partnership in cage culture development, the need to develop and institutionalize the sectoral HIV and AIDS policy and decentralization of some of the Fisheries Department sections are but some of the areas where progress could be made. On the positive side, the establishment of the Department of Fisheries and Aquaculture at the University of Malawi's Bunda College of Agriculture, for capacity building in fisheries, should be seen as a significant investment towards closing the capacity gaps in the country and the region.

Although fisheries involves quite a variety of stakeholders, a thing which makes it more complicated, it is clear that there is ample interest in developments in the area for numerous reasons, including socio-economic and environmental reasons. The differences in sizes and types of resource users in the fisheries sector imply that a lot of effort has to go into the tailoring of techniques to be promoted by the government, but it also means that a lot of challenges will be met in trying to enforce compliance with the chosen mechanisms. So far, it would appear there are a number of disjointed efforts, some of them duplicating the same facets of environmental and economic development, thereby failing to make a real impact. Harmonization of the policy context, implementation arrangements and the targets will be very critical for making a mark on both the socio-economic and environmental fronts of these efforts. This, too, is challenged by the smallness of investments in the fisheries sector, especially towards strengthening coordination and leadership for the implementation of activities of various stakeholders in the public and private circles.

3.7 Summary and Recommendations

Fish has been traditionally the most affordable source of protein among most Malawian, especially the rural communities. Fish prices have significantly increased from MK52/kg (US$0.54/kg) in 2003 to MK116/kg (US$0.83) in 2007, making fish less affordable to more people that before. It is very likely many people simply reduce their protein intake when faced with steep increases in real fish prices. It is estimated that around 66% of the Malawian population does not consume the minimum protein calories required

Due to a multiplicity of factors (increasing population, declining stocks, overfishing, increased exportation, among other), there has been a marked decline in per capita fish consumption in recent years. Per capita consumption was at 9.4 kg in 1990, but declined to 5.4 kg by 2008. Unless mitigating interventions are fully supported and implemented, consumption might decline to zero in 23 years.

This study estimates that there is a loss of MK3.9 billion (US$28 million) worth of fisheries resources each year, due to unsustainable fishing in natural bodies. This estimate represents 0.8% of GDP, and may increase if the trend remains unchecked.

Aquaculture production is still very low, staggering at around 2000 tonnes per annum, and contributing only about 2% of the total fish production of Malawi each year. Although aquaculture production has been growing steadily, it falls far short of meeting the excess demand for fish. Therefore, the capture fisheries sector remains the most dominant. However, Dey *et al* (2006) show that the development and dissemination of integrated aquaculture-agriculture (IAA) technologies in Malawi has a positive impact, in terms of increasing the overall profitability of both crop and fish production, as well as the overall returns to household labour.

Climate change may affect the sustainability of aquaculture production as increase in drought frequency may affect the life span of the ponds by accelerating their drying up.

The study makes following recommendations:

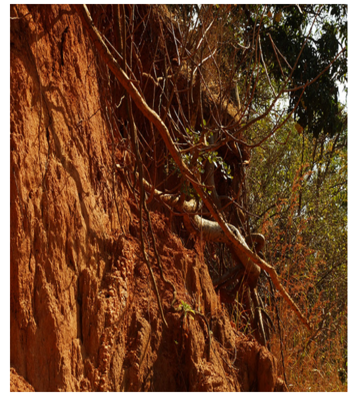
- There should be concerted efforts towards restoration of the degraded environment for fish breeding and growth, in order to assist recovery of fishery resource. Hence, there is need to develop models relating to biophysical and chemical nutrient effects to fisheries.
- There is need for specialized training to create capacity for handling methodological aspects of understanding the effects of climatic changes on fisheries resources.
- There is need for strengthening coordination and leadership for the implementation of activities that includes harmonizing of efforts towards fisheries development.
- There is need to sensitize the population to adopt the integrated aquaculture -agriculture intervention initiatives, in order to spread its benefits.

- Government should lead in investing in the development of clear monitoring mechanisms and the adaptation measures targeting to overcome the unsustainable fishery resource use

- Government and other stakeholders should promote cage culture that uses locally found materials such as bamboo would be a suitable venture for small scale farmers along the lakes.

4. Soil Resources

A: Malawi's rich soil



B: Soil erosion on Mount Zomba

A: From www.ipsnews.net as at 29/01/11
B: From www.flickr.com as at 29/01/11

Malawi's soils are of three major types: the Eutric leptisols, the Chromic levisols and the Haplic lixisols of variable morphology, with localised areas of Acrisols, Cambisols, Gleysols, Phaezems, Planosols and Vertisols. Over 80% of Malawians depend on agriculture as their major source of livelihood. Agriculture accounts for about 37% of the Malawi's GDP, and is a major foreign exchange earner for the country with tobacco alone contributing over 70% of export earnings. In all this, the country's topsoil remains an important natural resource. Yet this resource continues to be degraded at an accelerating pace. Soil erosion is caused by expansion of agriculture, deforestation, overgrazing, and land scarcity leading to people cultivating in marginal and fragile lands. These factors are a result of population growth. Scarcity of land predisposes land to short fallows or no fallows at all, and the resulting intensive land use tends to be erosive. The solutions to the problem of soil erosion are prescribed in the country's Agricultural Development Program (ADP), which is aimed at increasing agricultural area under Sustainable Land Management (SLM) from 100,000 to 250,000 hectares.

Estimates of soil loss based on a limited number of sample sites indicate an average loss of approximately 20t/ha/year. Studies that have translated this into yield losses suggest a 4% - 25% loss each year. A conservative estimate is that the annual on-site loss of agricultural productivity as a result of soil degradation costs MK7.5 billion (US$54 million) in 2007 which is 1.6% of GDP. In addition, soil erosion negatively affects hydro-electric power generation. Using data from ESCOM on the costs of minimising this impact, we estimate annual costs of some US$10 million in 2007 prices. We also identify small off-site impacts on drinking water treatment costs (approximately US$100,000 per annum for Blantyre Water Board alone) and impacts on the productivity of fisheries which we have not been able to quantify. Evidence from a computable general equilibrium (CGE) model of growth-poverty linkages in Malawi indicates that lost agricultural productivity from soil degradation over the period 2004 – 2015 will leave more than 1.88 million people in poverty who would otherwise have escaped it.

4.1 Characteristics of Soil Resources

Malawi is divided into four major physiographic units namely the highlands, plateau, rift valley escarpment and rift valley plains. The highlands are extensive highland tracts such as Nyika, Vipya, Mulanje, Zomba and Dedza mountains at elevations of 1,600 to 3,000 meters above sea level. The plateaus are located at elevations between 1,000 and 1,600 meters above sea level. The rift valley escarpments descend from plateaus with precipitous slopes. The rift valley plains are depositional plains extending from Lake Malawi shores and the Upper Shire River, at an elevation of 600 meters above sea level, to the Lower Shire below 100 meters in elevation.

According to the State of the Environment Report (1994), Malawi's soils are dominated by three major soil types: the Eutric leptisols (Lpe), the Chromic luvisols (LVx), and the Haplic lixisols (LXh) of variable morphology. There are also some localised areas of Acrisols, Cambisols, Gleysols, Phaezems, Planosols and Vertisols. The Eutric leptisols are commonly referred to as lithosols. The most widely spread of the lithosol group in Malawi are the shallow stony soils associated with steep slopes, covering an area of 2,243,390 hectares. These occur in all areas of broken relief.

The Chromic luvisols are commonly referred to as latosols. These red-yellowish soils include the ferruginous soils of the Lilongwe Plain and some parts of the Southern Region and are among the best agricultural soils in the country. These soils are generally of good structure and are normally deep and well drained. But they also include the weathered ferrallitic (plateau or sandveld) soils, some with a high lateritic content, which are of low natural fertility and become easily exhausted. These cover large parts of Malawi's plains, with a total area of 2,233,153 hectares. The Ferralic cambisols also have similar characteristics to some Chromic luvisols, but these mostly occur on the western border of the country.

The Haplic lixisols include the alluvial soils of the lacustrine and river-line plains, as well as the vertisols of the Lower Shire Valley and the Phalombe Plain and the mopanosols in the Liwonde and Balaka areas. They cover a total area of 1,671,495 hectares.

4.2 Significance of Soil in Malawi

In an agro-based economy such as Malawi's the importance of soil cannot be overemphasized as it has a very direct contribution to the agricultural economy. But soil is also important to the construction industry, particularly the making of bricks and the use of sand in construction. There is a growing small and medium pottery industry especially in central Malawi - Dedza and Nkhotakota districts - which is also a tourist attraction. In general, clay soils are used for artisanal pottery for cookery and water storage throughout the country. Soils also provide environmental services such as water purification, and it is also crucial in the control of the water table for electricity generation along the upper and mid Shire River. The degradation of soil resources, therefore, has far reaching consequences beyond the negative effects on the environment as such. The livelihoods of people involved in the various activities are likely to be affected as well through loss of jobs and incomes. Soil degradation, therefore, negatively affects soil supplies, fisheries, electricity generation, agriculture and water quality. In the current study, we used a wide range of data sources to quantify the impact on these areas.

4.3 Threats to Soil Resources

Degradation of soil resources has a direct and immediate impact, not only on the livelihoods of the people, but also on economic growth and the development of the country. Specifically, loss of soil means that either less will be produced for a given level of technology, or more inorganic fertilizers would have to be used in order to sustain agricultural production.

The National Environmental Action Plan (NEAP) identified soil erosion as one of the principal causes of environmental degradation in Malawi (GoM, 1994). From the perspective of soil erosion, Malawi is divided into 14 agro-ecological zones based on soil hazard and land degradation vulnerability. These are summarised in Annex 6.

Calculations from Eschweiler (1993) show that in 1989/90, only about 31.3% of Malawi's total area was suitable for cultivation, yet about one-half of the total land (48.6%) was actually under cultivation. This implies that much of the cultivation is being undertaken on unsuitable land. However less than 30% of the land is also under conservation in terms of use of recommended techniques and practices that can arrest soil erosion. Thus, according to the NEAP, soil erosion is largely caused by expansion of agriculture, deforestation, overgrazing, and land scarcity which leads to cultivation in marginal and fragile lands. Scarcity of land predisposes land to short or no fallows and the resulting land use tends to be erosive. Soil degradation is exacerbated by poor tillage practices, lack of soil conservation, as well as poor or absence of water control and water harvesting and conservation measures.

Although soil erosion causes considerable damage to the environment, its prominence is low in the MGDS. In the strategy, it is envisaged that reducing soil erosion would contribute to Theme One of the MGDS, i.e. Sustainable Economic Growth through increased yields of crops. This would be achieved through training farmers on low-cost soil fertility management techniques through extension services. If soil erosion is arrested, there will be a reduced need for the use of fertilisers to maintain productivity.

4.4 Extent and Cost of Soil Erosion in Malawi

4.4.1 General

The MoALD-PAPPA/PROSCARP report (1997) noted the following socio-economic effects of soil erosion:

- Soil erosion is a major cause of current levels of hunger and poverty in Malawi as it leads to reduced yields and/or increased use of inorganic fertilizer in order to produce enough food at the expense of purchasing other goods and services.
- As a result of declining yields (as shown in several studies cited in the report) and the lack of sustainable farmland, farmers are forced to increasingly cultivate on steep land which further exacerbates the level of soil erosion.

Thus, soil erosion is one of the major types of land degradation that pose a threat to sustainable agricultural production. Other land degradation factors include chemical degradation, surface capping (hardening of soil surface), loss of soil structure, loss of organic matter content, waterlogging, and acidification/alkalinization.

In this study, we assessed both the on-site and off-site impacts of land management and soil erosion, as summarised below. We recognise that focussing only on soil erosion underestimates total land degradation impacts. Due to data availability, we follow the World Bank (1992) and Bishop (1995).

4.4.2 On-Site Impact of Soil Erosion on Agriculture – Physical Impacts

Although no comprehensive studies have been conducted, results from spot trials of soil erosion under various cover and farming practices have shown that soil loss ranges from 0 to 50t/ha/year in various parts of the country (Amphlett, 1986; Kasambara, 1984; Machira, 1984). An erosion hazard map of Malawi compiled by Khonje and Machira (1987) shows the highest estimated soil loss to be 50t/ha/year. Unfortunately, these were conducted no less than ten years ago and were not nationwide. Additionally, these estimates are based on experimental plots. Other studies on soil erosion are: Soil Erosion Research Project at Bvumbwe (1981/82), World Bank (1992), Malawi Environmental Monitoring Program (1996), and Nakhumwa (2004).

The Soil Erosion Research Project at Bvumbwe was aimed at quantifying and comparing, through field measurements, the soil and nutrient losses from selected catchments under different land use and management practices (Amphlett, 1986). The study was conducted over four rainy seasons (1981 – 1985) in four catchment areas of Bvumbwe, Mindawo I, Mindawo II and Mphezo, representing full land use plan, traditional, physical conservation and plantation respectively. In all seasons, the unmanaged Mindawo gave the highest soil loss totals (4.44 – 14.32 tons per hectare in comparison to 0.03 – 0.13 tons per hectare per year at Bvumbwe. This also translated into larger losses of nutrients of Nitrogen between Mindawo and Bvumbwe respectively (0.31 kg/ha versus 0.0.13 kg/ha), Phosphorus (0.0.13 kg/ha versus 0.18 kg/ha) and Potassium (0.54 kg/ha versus 0.21 kg/ha). The findings implied that areas under conservation were more likely to experience less erosion and nutrient loss than those without conservation. Thus, land management can mitigate against soil erosion in vulnerable areas leading to less fertiliser being required under good soil management. The project was supposed to be scaled up but that never materialized.

The World Bank conducted a desk study in 1992 to assess soil loss in all eight Agricultural Development Divisions (ADDs) and their implications on yields. Table 32 shows the study results.

Table 32: Soil Loss and Weighted Average Yield Loss by ADD

ADD	*Arable Land (Ha)*	*Soil Loss (ton/ha/year)*	*Weighted Average Yield Loss (%)*	
			Low Impact	*High Impact*
Karonga	28,100	29	5.5	15.6
Mzuzu	42,5000	22	4.3	12.2
Kasungu	235,050	20	3.9	11.1
Lilongwe	231,150	22	4.2	12.1
Salima	46,400	16	3.1	8.8
Machinga	47,200	13	2.6	7.4
Blantyre	88,200	29	5.6	15.7
Shire valley	Na	17	3.2	9.3
Average	-	20	4.0	11.3

Source: World Bank (1992). Na = not available for the study

Thus, for Malawi, soil erosion was estimated at 20 tons per hectare per annum. This translated into average yield loss ranging from 4.0% for low impact to 11.3% for high impact areas. Some areas such as Karonga ADD and Blantyre ADD had yield loss of as high as 15.6% and 15.7%, respectively. Yet other areas had lower erosion rates. For example Salima and Machinga had 16 and 13 tons per hectare per year or erosion with the lowest impacts of 3.1% and 2.6% on average yield loss, respectively. Given the methodology used (secondary data analysis), it is erroneous to conclude that Malawi's soil loss is estimated at 20 tons per hectare per year as this study indicated. A more comprehensive study is needed to make that definitive statement and, given that Malawi is such a diverse country as far as its erosion characteristics are concerned, no single figure can cover the whole country. However, the strength of the study is that it demonstrated differences in the erosivity of the various ADDs.

The Malawi Environmental Monitoring Program (MEMP) study of 1996 was aimed at monitoring the impact of the liberalization of Burley tobacco growing among smallholder farmers on soil erosion. It was envisaged that tobacco growing would lead to increased soil erosion as the crop has less canopy hence it does not effectively protect the soil from raindrop impact. There were two types of field level plots of control and farmer plots. The Soil Loss Estimation Model for Southern Africa (SLEMSA) was used to determine the rates of soil and nutrient loss associated with cropping practices in sites in Nkhata Bay, Kasungu, Ntcheu, and Mangochi districts.

These studies were based on sampled plots in the sites. Unfortunately, only results of the baseline are available as the study never rolled nationwide. Among the four sites, only Nkhata Bay and Mangochi were assessed to be reliable for reporting. Average soil loss was estimated at 1.2 tons per hectare per year. This resulted in average nutrient losses of Nitrogen, Phosphorus and Potassium of 36 kg per hectare. The results are an indication of loss in soil fertility and crop productivity, which implies a loss in real incomes to communities that are already too poor to support their livelihoods sustainably.

Mlava *et al* (2010) estimated that soil erosion in the Linthipe cathment in 1994 was negligible at the minimum, but could reach 50 t/ha/annum. This, however, increased to assume an upper range of 57 t/ha/annum in 2008. In the Lower Shire catchment, erosion was estimated to be in the range 3 t/ha/year – 31 t/ha/annum in 2008. Focusing on slopes of less than 20% in the Linthipe catchment, Mlava *et al* further established a weighted average soil erosion of 12 t/ha/annum. This is lower that the World Bank (1992) estimate but compares favourably with Mkanda (2001) who, using 1991 land cover/land use data, found the Linthipe catchment to be within low to moderate soil loss (i.e., soil loss not exceeding 12.7 t/ha/annum). However, when slopes of greater than 20% were included, Mlava *et al* (2010) obtained an estimated soil erosion of 19.9 t/ha/annum, which was within the ranges documented by the World Bank (1992), and Bishop (1995).

The soil erosion estimates from the studies described above are summarised in Table 32 below.

4.4.3 On-Site Impact of Soil Erosion on Agriculture – Economic Impacts

The impact of soil erosion on agriculture arises from the loss of soil nutrients leading to a negative nutrient balance as nutrient requirements fall short of actual consumption. Based on the MEMP (1996) study, at one sampling site in Nkhata Bay (Chilindamaji), there was an estimated loss of NPK of 433 kg per hectare. This was equivalent to MK2,640 at 1995 fertilizer cost, at a time when about 80% of the households earned less than MK214 per capita per annum.

A study by Nakhumwa (2004) quoted results from the International Fertilizer Development Corporation (IFDC) which showed that annual soil nutrient balance was negative between 1993 and

1995, as Table below shows. This suggests a need to supply extra nutrients especially through supply of inorganic fertilizers or indeed a change in agricultural practices to make them sustainable.

Table 33: Estimated Soil Loss and Estimated Economic Costs from Existing Studies

Study	*Estimated physical impact*	*Estimated on-site cost*
Khonje and Machira (1987)	Highest erosion estimated at 50 tons per hectare per annum (based on the Malawi soil hazard map of Malawi)	Not calculated
Kasambara (1984), Machira (1984)	Estimated soil erosion to range from 0 to 50 tons per hectare per annum	Not calculated
Amphlett (1986)	4 to 14 tons per hectare per year at Bvumbwe (one site)	Not calculated
Bvumbwe Soil Erosion Project (1982)	16.4 tons per hectare per annum at Mindawo and 0.15 tons per hectare per annum at Bvumbwe[55]	Not calculated
World Bank (1992)	National average of 20 tons per hectare per annum	On-site costs only. 4% to 11% annual yield reduction leading to loss of MK10-MK29 per hectare per year. Annual loss of 0.5 – 1.5% of GDP (1988). With a 10% discount rate, the annualized cost over 10 year is 3.8% – 10.9% of GDP (1988)
Bishop (1995)	National average of 20 tons per hectare per annum (range of 10 – 50 t/ha)	On-site costs: 8% – 25% annual crop yield reduction leading to a loss of MK20–MK64/ha/year in 1990 prices. This translates to an annual loss of 2.4%-7.7% of agricultural GDP (1990). With a 10% discount rate, the annualized cost over 10 year is approximately 7% - 24% of GDP (1990)[56]
MEMP (1996)	1.2 tons per hectare per annum from two case study sites	On site cost: Estimated average replacement cost of 36kg NPK fertiliser/ha is MK219/ha/year (US$9.65/ha)
Nakhumwa (2004)	Used the 20 tons per hectare per annum soil loss estimated by the World Bank (1992). Case studies from two sites to estimate soil nutrient loss for given soil loss.	On site cost: Nutrient replacement cost estimated as US$21 per hectare per year. For all small-holder farms this cost equals 14% of agricultural GDP
Yaron, et al (2009)	National average of 20 tons per hectare per annum (range of 10 – 57 t/ha)	On site costs: As for Bishop (1995) MK20–MK64/ha/year in 1990 prices = MK790-2527/ha/yr (US$5.7-US$18.2/ha/yr) in 2007 prices. Harvest area (km^2) estimates range from 30,500 – 50,146 – World Bank/Bishop. Annual costs range from MK2.4Bn to MK12.7Bn (US$17.3 - US$91 million/year).

[56] Derived from reported data on agricultural GDP lost using the ratio of agricultural GDP: total GDP in 1988 in World Bank (1992).

Table 34: Annual Nutrient Balance in Malawi (1993 – 1995)

Nutrient	*NPK (000MT)[a]*	*N (kgha-1)*	*P (kgha-1)*	*K (kgha-1)*	*NPK (kgha-1)*
Annual nutrient requirement	263.8	38.9	37.0	54.1	130
Annual nutrient consumption	61.4	18.9	8.4	3.0	30
Nutrient balance	-220.8	-47.5	-16.0	-45.3	-108.8

Source: Nakhumwa (2004). [a]These figures are based on 3,029,000 hectares of land.

To further investigate the issue of soil nutrients supplementation and related issues, Nakhumwa (2004) focused his study on 120 respondents from Nkhata Bay district in northern Malawi and 143 from Mangochi district in southern Malawi. The sample was made of 50% respondents who were still using conservation technologies[57] two years after the phasing out of the MEMP project, and 50% who had stopped using the technologies. Other than collecting socio-economic data, a soil survey was conducted to establish soil characteristics of the sites and these data were linked with secondary data from other sources to estimate soil erosion using the SLEMSA. The data in Table shows the impact of adopting soil conservation measures established by the study.

Table 33: Comparative Analysis of Soil Management Techniques

Variable	*Steady State*	*Current Practice[58]*
N-stock (ton/ha)	1.6	1.4
Fertilizer (kg/ha)	49	15
Output level (tons/ha)	1.5	0.75
Change on soil stock (kg/ha)	0	-20
Erosion level (cm-soil depth/ha)	0.15	0.2

Source: Nakhumwa (2004).

Under current practice, the study showed that there was soil loss of 1.4 tons per hectare of nitrogen against 1.6 tons per hectare under dynamic optimization. Under the latter, farmers would apply 49 kg of N per hectare against 15 kg for the current practice. However, the yield under dynamic optimization[59] would be twice as much (1.5 tons per hectare) as what farmers were currently getting (0.75 tons per hectare). Under current practices, more soil was being eroded (0.2 cm of soil per hectare) than under dynamic optimization (0.15 cm per hectare). The most important finding was that under current smallholder soil management practice, annual loss of productive value of land was US$21 per hectare[60]. This translated into 14% of Malawi's agricultural GDP, or MK4.5 billion (US$41 million).

It is important to note that the studies reported in Table 32 only calculated on-site impacts. These impacts were valued either by the cost of replacing lost nutrients or in terms of lost agricultural production. Studies that estimated the cost of replacing lost soil nutrients with commercial fertiliser

[57] Conservation technologies refer to such technologies that keep the soil in the same state i.e. without erosion being experienced.

[58] Current practice refers to what farmers are currently doing that is leading to depletion of nutrients from the soil in this study estimated at 20 kg per hectare.

[59] Steady state and dynamic optimization can be used interchangeably to refer to a situation in which the agricultural practices being used are able to replace the soil nutrients being extracted so that on balance the nutrient loss is zero.

[60] This loss is based value of nutrients lost per annum.

typically found the highest costs of soil erosion – US$10 – US21/hectare per year. As small scale farmers do not (and cannot afford to) purchase these replacement nutrients, more recent studies have tended to focus on estimating the value of lost crop yields from soil erosion. Drawing on field experiment data linking crop yield decline to soil erosion, the 1992 World Bank study estimated an average annual agricultural yield loss of 4 – 11% as a result of soil erosion, while Bishop (1995) estimated mean annual yield losses of 8 – 25%. The latter translates to a cost/ha of US$5.7 – US$18.2 at 2007 prices.

On-site soil erosion estimates do not take into account soil deposition within catchments i.e. downstream farmers gaining from the loss of upstream farmers. This tends to overstate the total loss of soil and hence yield. While this is much less of an issue in Malawi than in countries reliant on flood plain farming, we minimised the risk of overestimating this economic cost by taking the bottom of the range of the yield loss estimates in the World Bank (1992) and Bishop (1995) studies. This observation was supported by the evidence that soil erosion estimates in the Linthipe catchment were lower than those documented by the World Bank (1992) and Bishop (1995), as shown by Mlava *et al* (2010). Our estimation gave an average yield loss of 6% per annum.

The CGE model for Malawi developed by Benin et al (2008) under the International Food Policy Research Institute (IFPRI) quantified the impact of changes in agricultural yields on GDP growth. By linking the CGE projections to household survey income data from the Integrated Household Survey No. 2 (IHS2), Benin et al were able to investigate how changes in agricultural productivity affected poverty – see Box 4 below. This is very useful for this study as it allows us to consider the impact of on-site soil erosion - defined in terms of reduced agricultural productivity - on poverty.

The IFPRI model forecast that achieving 6% growth in agricultural yields during 2005-2015, would increase the overall GDP growth rate from 3.2% to 4.8% per year[61], leading to the proportion in poverty falling to 34.5% by 2015. This is considerably lower than the 47.0% poverty rate projected in the absence of the additional agricultural growth. The 6% agricultural yield growth results in an additional 1.88 million people being lifted above the poverty line by 2015.

A logical corollary of this argument is that losing this growth in agricultural yield as a result of soil degradation will result in losing the increment in GDP growth and its consequent reduction in the number of people in poverty. Based on the estimates of Benin et al (2008), we argue that an annual crop yield reduction of 6% as a result of on-site soil erosion will lead to total GDP being reduced by approximately 1.6% each year. The evidence from the World Bank (1992) and Bishop (1995) studies is that crop yield reductions from soil erosion are likely to be considerably higher than this. Nevertheless, taking the highly conservative view that the on-site impact on agriculture of soil degradation corresponds to losing 6% of agricultural yields. The implication is that the failure to tackle soil erosion from poor agricultural land management practices would result in more than 1.88 million people remaining in poverty over the decade to 2015.

Another way of looking at the cumulative impact of soil erosion over time is to consider the discounted value over a number of years. From the studies reported in the Table below we see that the estimated annualised costs of on-site impacts (obtained by discounting the annual values over 10

[61] This is the difference between the Baseline and CAADP growth scenarios in Section 4 of Benin et al (2008)

years, typically using a discount rate of 10%) average 5% - 17% of total GDP. This is significantly more than total spending on public education in Malawi[62].

Box 4: The CGE and micro-simulation model for Malawi developed by Benin et al (2008)

A Malawi CGE model was developed to capture trade-offs and synergies from accelerating growth in alternative agricultural sub-sectors, as well as the economic inter-linkages between agriculture and the rest of the economy. Although this study focuses on the agricultural sector, the CGE model also contains information on the non-agricultural sectors, for a total of 36 identified sub-sectors, 17 of which are in agriculture. The agricultural crops considered herein fall into five broad groups: (i) cereal crops, which are separated into maize, rice, and other cereals, such as sorghum and millet; (ii) root crops, such as cassava, Irish potatoes, and sweet potatoes; (iii) pulses and nuts, which is separated into pulses and oil crops, and groundnuts and other nuts; (iv) horticulture, which is separated into vegetables and fruits; and v) higher-value export-oriented crops, which are separated into tobacco, cotton, sugar, tea, and other export crops, such as sunflower seeds. The CGE model also identifies two livestock sub-sectors, namely poultry, and other livestock, such as cattle, sheep, goats and pigs. To complete the agricultural sector, the model has two further sub-sectors capturing forestry and fisheries. Most of the agricultural commodities listed above are not only exported or consumed by households, but are also used as inputs into various processing activities in the manufacturing sector.

The Computer generated model endogenously estimates the impact of alternative growth paths on the incomes of various household groups. These household groups include both farm and non-farm households, and are also disaggregated across the nine regions and rural and urban areas. The rural farm households are further separated by land size into small-, medium- and large-scale farm households. Each of the households included in the 2004-05 Integrated Household Survey (IHS2) (NSO, 2005) are linked directly to their corresponding representative household in the CGE model. This is the micro-simulation component of the new Malawian model. In this formulation of the model, changes in representative households' consumption and prices in the CGE model are passed down to their corresponding households in the survey, where total consumption expenditures are recalculated. The new level of per capita expenditure for each survey household is compared to the official poverty line, and standard poverty measures are recalculated. Thus, poverty is measured in exactly the same way as in official poverty estimates, and changes in poverty draw on the consumption patterns, income distribution and poverty rates captured in IHS2.

Source: Benin S., Thurlow J., Xinshen D., McCool C. and F Simtowe, Agricultural Growth and Investment Options for Poverty Reduction in Malawi, IFPRI Discussion Paper 00794, September 2008

4.4.4 Off-Site Impacts of Soil Erosion: The Impact on Hydro-Electric Power Generation

Direct impact of siltation

ESCOM argues that "due to environmental degradation and bad farming practices in the catchment area of the Shire River and its tributaries, large quantities of silt are deposited in ESCOM's Hydropower Stations' reservoirs thereby reducing their live storage capacity and necessitating dredging. Silt also accelerates wear of waterways and turbine parts thereby increasing the operational costs through frequent replacement of parts and power plant outages"[63]. Survey data from 2004 indicated that across both formal and informal sector businesses, median losses in sales due to power outages in Malawi averaged 10% of total sales. In addition, as a result of unreliable electricity, about 50% of firms

[62] Southern African Regional Universities Association: http://www.sarua.org/?q=Malawi
[63] http://www.escommw.com/generation_efforts.php

invested in generators[64.] The Millennium Challenge Corporation (MCC) estimated that unserved energy was costing Malawi US$215 million annually[65].

There are many factors that cause power outages in Malawi and only some of them relate to unsustainable natural resource use. For example, around 70% of the proposed MCC investment programme to address power outages focuses on rehabilitating the transmission system that has little or nothing to do with soil erosion[66]. As it was not possible to isolate the impact of siltation from climatological and other factors causing power outages we focused on the costs of mitigating the impact of siltation on power generation. These costs were only borne because of the problem of soil erosion. With information from ESCOM we were able to estimate:

1. Detailed capital and operating costs of dredging at the Nkula Hydropower Plant.

And using figures from the MCC study we estimated:

2. Detailed capital and operating costs of extending dredging to the Tedzani and Kapichira plants.

This allowed us to estimate the costs of minimising the impact of soil erosion on hydro-electric power generation. These "prevention costs" (see Annex 9) would tend to underestimate actual costs to the extent that some damage from soil erosion still occurs.

Weed and trash impacts
Again, based on detailed information from ESCOM, we estimated capital and operating costs of tackling the weed and trash problems arising frequently in recent years as a result of the increased soil and nutrient deposition in the Shire River. These relate to the weed barrage at Liwonde and planned trash diversion works (see Annex 9).

In this case we also had data on power outages resulting directly from weed-related and trash-related maintenance that had arisen during the Jan-March 09 period despite the interventions to control the weed problem. We assumed a cost of unserved energy (COUE) of US$0.22/kWh as used by MCC (2009) and World Bank (2007)[67]. As we did not include the capital cost of replacement of generator parts, we almost certainly underestimated weed and trash-related costs[68].

Table summarises the estimated annual cost of soil erosion on hydroelectric power in Malawi. In total these amounted to more than MK 1.4 billion (almost US$10 million) each year, equivalent to approximately 0.3% of total GDP at 2007 prices.

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[64] MCC (2009), Compact Program for the Government of the Republic of Malawi (2011 – 2016): Concept Paper, MCC Lilongwe
[65] Reported in The Nation newspaper of 14 March 2010.
[66] MCC, Compact Program for the Government of the Republic of Malawi 2011 – 2016, Concept Paper for the Energy Sector
[67] As some customers face rationing during normal operation, additional outages are valued at the COUE.
[68] It has not been possible to reliably identify that proportion of generator replacement costs attributable to weed and trash damage from increased soil and nutrient deposition.

Table 34: Estimated annual cost of soil erosion on hydropower in Malawi

Capital cost (depreciated)	***Operating cost***	***COUE***	***Total***
MK115,341,606	MK83,986,000	MK1,234,028,496	MK1,433,356,102
US$790,090	US$575,304	US$8,453,095	US$9,818,489

These off-site costs of MK 1.4 billion (US$10 million) per annum would mount up over time. The annualised cost over 10 years with a 10% discount rate is nearly MK10 billion (US$66 million) or 1.9% of GDP at 2007 prices. The effect of soil erosion on hydropower generation had several impacts at household level. First, increased cost on power generation arising from soil erosion is likely to be passed on to the consumers through increased tariffs. Secondly, soil erosion also results in load shading which in turn results in households resorting to using other environmentally harmful sources of energy such as charcoal.

4.4.5 Off-Site Impacts of Soil Erosion: Impacts on Water Treatment and Fisheries

Case study evidence collected for the Lower and Middle Shire catchments for this study indicated further off-site costs resulting from soil erosion in terms of additional water treatment chemical costs.

Data on raw water treatment costs from Blantyre Water Board and evidence from Dearmont et al (1998) on the relationship between turbidity and drinking water treatment costs in the United States allowed us to indicate the magnitude of likely costs. These are shown in Table below.

Table 35: Estimated Impact of Soil Erosion on Water Treatment Costs

% increase in chemical costs for a 1% increase in turbidity*	0.25%	
	US$	MK
Total water chemical treatment costs for 2008 (Blantyre)	415,949	60,722,521
Additional chemical treatment costs for turbidity increase of:		
10%	10,399	
50%	51,994	
100%	103,987	15,180,630
Cost of 100% increase in turbidity as % of GDP	0.003%	

* based on Dearmont et al (1998)

If unsustainable land management results in the doubling of turbidity, the annual treatment cost increases for the Blantyre water supply is in the order of MK15 million (US$100,000). Taking other water treatment plants into account, this figure is likely to be larger. Moreover, there is a chance that some water treatment plants boards may not be able to treat the water to the required standard therefore giving their consumers substandard water. Health costs would therefore have to be taken into account.

The economic impact of increased turbidity on fisheries is potentially large because a fairly significant population of Malawi depends on fish from Lake Malawi, either as part of their livelihood or within their diet. However, evidence on changes in turbidity and the relationship between turbidity and fishery productivity in Malawi was not available. It was therefore unfortunately impossible to quantify this impact.

4.4.6 Off-Site Impacts of Soil Erosion: Impacts on Irrigation

The case study of the Lower Shire Catchment (see Annex 10) provides some interesting evidence on the potential impact of siltation on irrigation. Siltation in rivers and irrigation schemes in the catchment call for dredging and clearing of irrigation channels, and account for reduced irrigation water quantity. This in turn requires investments in river protection and catchment conservation. According to the Government of Malawi's Irrigation, Rural Livelihoods and Development Project (GoM, IRLAD, 2009) Nkhate Irrigation Scheme requires MK67, 587,300 (US$0.48 million) for river protection works and MK 80,702,100 (US$0.58 million) for catchment conservation in the Thyolo Escarpment. For Muona Irrigation Scheme, MK 32,823,400 (US$0.23 million) is required for river protection works and MK 47,262,900 (US$0.34 million) for Thyolo Escarpment conservation.

Another effect experienced by farmers is the inability to sustain pumping costs which have arisen because of a lowered water table. This is due to poor water retention arising from soil erosion. On average, the water table had dropped by 2 meters below land surface over the period 1994 - 2008. Moreover, irrigation technologies and equipment are under- utilized due to drying rivers. There are also serious salinity problems in some sites such as Chitsa hindering irrigation development. Data from Nsanje District indicates that nearly half of all treadle pump and canal-based irrigation are no longer functioning and the primary cause is siltation.

In order to get a picture of the difference this makes in economic terms we drew on FAO (1997) that provides data on the financial returns to irrigated versus rain-fed agriculture in Malawi. To illustrate the issue we focused on the difference in the gross margin earned by small-scale maize farmers with and without irrigation. Using the FAO figures, we established that after allowing for the costs of irrigation, the additional annual gross margin (profit) earned by maize farmers with irrigation was US$1,235/ha. This amount was lost in each hectare where siltation had caused the irrigation not to function. This not taking into account the fixed costs which will have already been incurred.

If the situation in Nsanje was common to all irrigated land in Malawi – 76,410 ha according to FAO (1996) – the cost would be truly enormous. The loss in gross margin would be more than US$45 million a year. We simply do not know how much irrigation is non-functional due to siltation nationally but anecdotal evidence suggests that the problems affecting irrigation in the lower Shire are particularly severe and reflect design problems as well as siltation[69]. As we desired to present a cautious set of estimates of economic costs from unsustainable natural resource use we did not include a national cost of lost irrigated agricultural production. However, the case study evidence demonstrated that policy makers should take this issue seriously.

4.5 Interventions, Costs and Benefits of Soil Conservation

Soil conservation is a responsibility of four Ministries/Departments, namely the Ministry of Agriculture and Food Security, the Land Resources Conservation Department (LRCD), the Department of Irrigation, and the Department of Agricultural Extension Services. A number of interventions to promote soil conservation have been sponsored by the Government. For example, the LRCD has developed a wide range of low cost techniques which have been successfully promoted among smallholder farmers.

[69] P. Jere personal communication 2010.

There is also the National Land Resource Management Policy and Strategy 2000 and the Strategy for Sustainable Soil Fertility Management and Food Security in Malawi (2002). These provide guidelines for implementation of land management programmes. Perhaps the most significant government programme is the Agricultural Development Programme (ADP) under Focus Area III, which is aimed at increasing agricultural area under Sustainable Land Management (SLM) from 100,000 to 250,000 hectares. The increase in land under SLM is seen as being both achievable and realistic. This would be achieved through:

a. Promotion of conservation farming (use of best bet technologies that build and sustain soil fertility, prevent soil erosion, conserve soil moisture, and promote efficient utilization of rain or irrigation water);
b. Promotion of labour-saving technologies (land ploughing using hired tractor or own tractor, herbicides for weed management and crop protection agents);
c. Promotion of management systems and technologies that protect fragile land (river banks, *dambo* areas, steep slopes or hilly areas, and water catchment areas);
d. Promotion of community based *dambo*[70] management systems; and
e. Subsidizing inputs to raise forestry and fruit tree seedlings or buying of plants from commercial nurseries for farmers and village communities for planting on fragile or degraded land areas

Some evidence on the costs and benefits of conservation farming (CF) in Malawi can be drawn from the experiences of the Total Land Care (TLC) in the Chia Lagoon Project, the FAO Enhancing Food Security and Developing Sustainable Rural Livelihoods (EFSDSRL) Project, and the EU Promotion of Soil Conservation and Rural Production (PROSCARP) Project. This can be supplemented by the extensive review of CF in Zambia by Haggblade and Tembo (2003).

It should be noted at the outset that the cost-benefit analysis of CF presented in this report is limited by:

- *The use of different combinations of technologies by these projects.* For example, the Chia Lagoon Project uses permanent ridges whereas the Zambian CF review considers small permanent basins. The Zambian CF projects are "strict" CF using no-till seed establishment plus the incorporation of intercropped annual species planted with the main crop[71]. In contrast, the other projects use Conservation Agriculture (CA) which combines CF techniques with agro-forestry to improve soil fertility. The Chia Lagoon Project Final Report[72] and EFSDSRL project mid-term review[73] use the terms CF and CA interchangeably but technically speaking these are CA projects. PROSCARP has delivered training to improve soil conservation and fertility using both CF and CA interventions so that some farmers use CF while others use broader CA techniques.

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[70] *Dambos* are low-lying areas which usually have residual moisture during the dry season.
[71] As Williams (2008) argues, the purpose of this annual intercropping can be "nitrogen fixation, soil protection and crop diversity" p13
[72] Chia Partner Alliance (2008), CHIA LAGOON WATERSHED MANAGEMENT PROJECT: FINAL REPORT: OCTOBER 2004 TO DECEMBER 2007, USAID
Volume I: Technical and Financial Report
[73] Laugerud T, Mkandawire S. R., and E. J., Kantchewa (2009), Mid-term Review of: Enhancing Food Security and developing Sustainable Rural Livelihoods Project, Norad, P.O. Box 8034 Dep, NO- 0030 OSLO

- *The importance of complementary interventions to CF or CA.* For example, Conservation Agriculture is seen as one of the most successful elements of the EFSDSRL project but this success is not simply about the CA technologies but also reflects the method of demonstrating the benefits of CA to farmers and the use of Revolving Funds to enable farmers to purchase herbicides and fertilizer.

With these caveats in mind we first considered *Contour ridging and planting of vetiver hedgerows.* In the Middle Shire case study prepared by Mlava et al (2010), they argue that the traditional contour ridging technology is what most farmers are using and under this technology farmers plant on ridges 75-90 cm apart reconstructed every year; and weeding once and earthing up the ridge using a hoe.

Based both on international experience and considerable experience within Malawi over the past 20 years[74] we can say that contour marker ridges should be used to realign crop ridges to the contour on all cultivated land with slopes greater than 3% but less than 13%. Almost 54% of the Middle Shire catchment has such characteristics. Mlava et al (2010) argue that this would control runoff and erosion and increase infiltration, particularly when used in combination with tied ridges.

Vetiver (or other thick stemmed grasses) should be planted on contour markers and managed to form vetiver hedgerows which provide a barrier to runoff. This causes deposition of eroded soil, greater infiltration of water above the hedgerow and "natural terracing" of the land. The PROSCARP project has found Vetiver to be very efficient against erosion and for water retention, even on steep slopes[75].

According to an analysis by TLC (2002), the cost per hectare under marker ridges is MK900 while under aligned ridges is MK2400. The cost per length of vetiver hedge is MK4950 per hectare. Hence if all activities are undertaken the total cost would be MK8250/ha (US$ 57/ha).

PROSCARP *project* costs show a total annual cost for the same activities of MK6356/ha[76]. However, once conservative estimates of farmer labour costs are included (see the Table below), total costs rise to approximately MK11,000/ha (US$73.3/ha) in year 1, but decline to MK600/ha (US$4.0/ha) in subsequent years.

Benefits from these soil conservation interventions accrue off-site (e.g. reduced costs faced by hydroelectricity generators) and to farmers who introduce them. However, it can take some time for farmers to realise these benefits in terms of increased yields. Mlava et al (2010, p18) conclude that "research shows that these measures are all effective against erosion and do reduce runoff. The improvements in yield and productivity however are less clear and may take time to be established. Increased water conservation can give a direct and immediate yield improvement in dry years but may make little difference in normal years. Controlling erosion to acceptable levels reduces the rate of decline in yield through retaining the more productive top soil. The benefit is apparent much more quickly on shallow soils than deep soils. Losses from runoff washouts would be reduced immediately".

In Section 6 we report that we estimated the off-site hydroelectricity costs from soil erosion to be MK 1,433 million (US$ 10 million) per year. As the Middle Shire catchment is the principal source of hydroelectric generation in Malawi (and the basis for our cost estimates), this cost was allocated to

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[74] See: TLC (2002), Best-bet Agroforestry and Soil Conservation Practices. A Booklet produced by Bunderson, W.T., Z.D. Jere, I.M. Hayes Malawi Agroforestry Extension Project, Publication No. 43, Lilongwe

[75] Sofreco (2003), Final Evaluation of the Promotion of Soil Conservation And Rural Production (Proscarp) Project.

[76] Overall unit costs for WP 7

the area of farmland in the catchment. Remote sensing undertaken for this study indicated 689,300 ha of farmland in the Middle Shire. Hence if the soil conservation interventions are successful we can argue that they produce an off-site value of MK 2,079/ha (US$ 14.2/ha) in this catchment[77].

As noted above, the impact on agricultural yields is likely to build up over time. Unfortunately, at the time of writing we did not have estimates of soil loss (hence yield loss) for the Middle Shire catchment. Using average figures for Malawi from Section 6 and assuming that this intervention reduces yield losses attributed to soil erosion in year 1 by 20%, rising to 100% in year 5 we estimated on-site benefits rising from nearly MK 500/ha in year 1 rising to nearly MK 2,500/ha (US$17/ha) in year 5. The results are in Table .

Table 36: Soil Conservation Cost and Benefit Data

Annual project cost of marker ridges, ridge realignment & vetiver grass planting (MK)	6356
Farmer days required in year 1 – indicative	80
Farmer days required in subsequent years – indicative	10
Average labour cost/day (based on low return farming activities, Fisher et al (2005)) MK	59.49
Total labour cost borne by farmer - year 1	4,759
Total labour cost borne by farmer - years 2 onwards	595
Annual off-site impact of soil erosion on hydropower/ha farmland in Middle Shire (MK)	2,079
Annual impact of soil erosion on yields/ha cultivated farmland in Malawi (MK)	2,472

Sources: PROSCARP Project and data from this study

Over a 10 year period, the estimated economic internal rate of return to these interventions is 42% (i.e. this intervention would produce a positive net present value with a discount rate of up to 42%). As the discount rate for socially beneficial projects is often taken to be 3% the economic justification for this kind of soil conservation project is very strong. Even if there were no yield benefits to farmers this project could be justified on economic grounds as the estimated IRR on the basis of off-site benefits alone is 16%.

The picture looks somewhat different from the farmer's perspective. Drawing on data presented in Figure 12 of the PROSCARP final report we estimate that the financial cost of marker ridges, ridge realignment and vetiver grass planting is MK 4115/ha. Other data presented in Table remains the same although from the farmer's point of view the off-site benefit has no financial value.

Over a 10 year period, the estimated financial internal rate of return is just below 10%. As we have discussed in Section 0, the private discount rate of small farmers in Malawi is many times this level. A number of implications follow logically from these results:

1. Farmer's will not undertake these soil conservation interventions unless there are enough incentives or are compelled to do so.

2. As these interventions are clearly justified from a National (economic) perspective, the Government of Malawi should consider paying farmers who provide this environmental service.

[77] It may be argued that allocating all the off-site benefits to this catchment overstates the per ha benefit. However, we have only considered the off-site benefits to hydro-electric generation and excluding impacts on all other sectors results in an underestimate of per ha benefits.

3. As the private discount rate of many farmers is likely to be higher than the social return to this intervention, paying what it is worth to the Nation is probably not enough *by itself* to encourage most farmers to adopt soil conservation interventions. However, if soil conservation interventions can be combined with conservation agriculture to raise yields significantly in the short term the package as a whole is likely to change farmer behaviour.

Considering *conservation agriculture,* a number of existing studies demonstrate that minimum tillage combined with undersowing with Tephrosia vogelii has the potential to significantly increase maize yields and farm profitability if farmers apply fertilizer (and ideally herbicides). The mid-term review of the EFSDSRL project concludes that "The activities with the best effect is beyond doubt the ones on CA, where the good demonstration effect has made some additional farmers adopting the techniques without support from the Project, buying input materials with own funds" Williams (2008, p19) surveying farmers in the TLC Chia Lagoon project finds that 98% of farmers trying conservation agriculture were satisfied with the results.

Hayes et al. (1999) report the results of two farmer field trials involving undersowing Tephrosia vogelii and maize. The first trial involved undersowing *Tephrosia* with maize in year 1 with normal ridging. Sowing involved 2 stations of *Tephrosia* between maize stations on every ridge at 3 seeds/station 2 cm deep. In year 2, *Tephrosia* was left as a fallow with no tillage. It was then cut down just before the onset of year 3. Leaf biomass was left on the soil surface and stems were removed for fuelwood. Thereafter, maize was cultivated under a system of reduced tillage with *Tephrosia* undersown again at the start of year 5 to repeat the cycle.

In the first trial the following six trial plots were analysed:

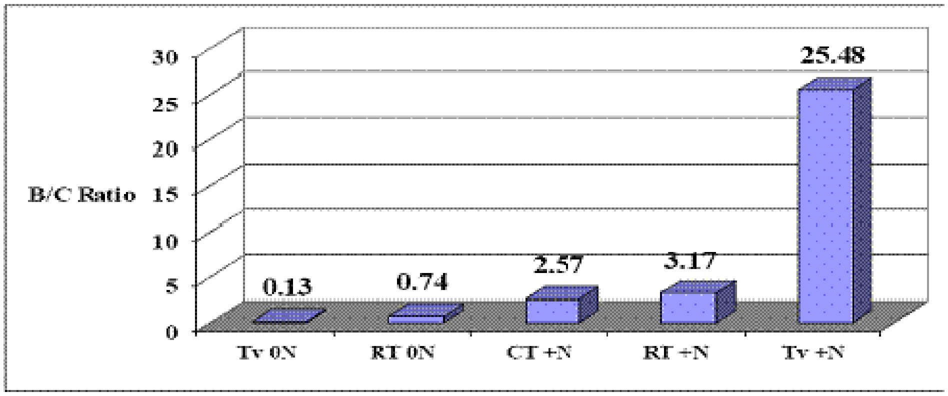
1. Maize conventional tillage CT 0N
2. Maize +N conventional tillage CT +N
3. Maize reduced tillage RT 0N
4. Maize +N reduced tillage RT +N
5. Maize Tv reduced tillage Tv 0N
6. Maize Tv +N reduced tillage Tv +N

Figure 6 illustrates their financial cost-benefit analysis for each of the main options. This shows that over a five year period the discounted benefits (at a 50% discount rate) of undersowing maize with reduced tillage and fertilizer are more than 25 times discounted costs. Provided farmers have access to fertilizer this intervention will be extremely financially attractive[78]. Projects such as EFSDSRL and the Chia Lagoon Project have ensured this by making loans to farmers that are repaid from the increased crop yields.

It is important to note that this cost-benefit analysis shows that undersowing with a fallow season is recommended only with fertilizer due to the loss of production in the fallow phase unless this land is not planned for cultivation.

[78] To put this in context the financial benefit-cost ratio estimated for soil conservation interventions would be 0.4 at a 50% discount rate and even the economic benefit-cost ratio would only be 0.9 at this discount rate.

Figure 6: Benefit-Cost Ratios (at 50%) Trial 1



Source: Hayes et al. (1999)

The reduced tillage practice common to CF and CA also does involve significantly more labour input in the first year (particularly for weeding) unless herbicides are available. Although, as Haggblade and Tembo (2003) explain, dry-season land preparation, though arduous in early years, becomes easier over time and the redeployment of field preparation labor and draft power to the off-season relieves peak season labour bottlenecks, thus enabling early planting and early weeding.

4.6 Conclusions and Recommendations

Studies carried out in Malawi have demonstrated that land degradation in general and soil erosion in particular are a problem. Although no nationwide study has been carried out to show the extent of the problem, a few studies carried out have demonstrated that soil erosion is present and has negative effect on the agricultural sector and non-agricultural sectors. From both on-site and off-site effects, soil erosion affects other sectors of the economy such as hydropower generation. These effects have been well documented in other studies as well we this one.

Some programmes have also demonstrated that techniques and technologies exist to mitigate against these effect of soil erosion. Although national wide benefits have been demonstrated to occur, for the activities to be realized, individual actions have to be undertaken. Thus a case for free riding is present. It is in view of these that the following recommendations are made to improve the management of soil resource.

1. An appeal should be made to farmers to adopt recommended technologies and techniques of conservation practices which must also enable them to make more profit on a sustainable basis. Hence the programmes field level interventions should seek to bring tangible economic, social as well as environmental benefits to the direct stakeholders.

2. Conservation needs to do more than just rehabilitate the environment. Tackling the associated problems of food insecurity and soil degradation within Malawi calls for a long term (10-20 years) investment programme that can provide the human and financial resources required to implement a national strategy supported by Government and other relevant institutions such as Water Boards and ESCOM. Most initiatives tend to have a short time horizon.

5. Wildlife Resources

Elephants and hippos at Vwaza Marsh Wildlife Reserve.

From www.ilovemalawi.blogspot.com as at 29/01/11

The wildlife estate in Malawi covers considerable land area containing ecosystems and biodiversity necessary for the maintenance of various goods and services such as provisioning services (food, fiber, water and fuelwood); regulating services (air-quality maintenance, climate regulation, water regulation, erosion control); cultural services (spiritual and religious value, aesthetic values, cultural heritage values, recreation and ecotourism); and support services (soil formation, nutrient cycling, water cycling, production of atmospheric oxygen. Importantly, wildlife resources contribute to the country's economy. Unfortunately, unprecedented loss in wildlife resources primarily caused by unsustainable utilisation through poaching and illegal settlements by surrounding communities is of serious concern. This undermines the future of using the wildlife estates for tourism and recreation, education and research in biodiversity. The loss in biodiversity has the potential to curtail future scientific discoveries important in medicine and agriculture.

In monetary terms, we have demonstrated with a case study the huge asset value of Malawi's wildlife resources. Lengwe National Park alone holds a stock of wildlife valued at US$17.7 million (MK2.5 billion). This is despite that all animal numbers in this park are below the carrying capacity. Based on the park restocking plan, and carrying capacities the economic value of the animals in this park will rise to approximately MK11.2 billion (US$80 million).

5.1 Characteristics of Wildlife Resources

Conservation of wildlife resources is part of the country's overall land use plan with the wildlife estate embracing five national parks (NPs), four wildlife reserves (WRs) and three nature sanctuaries (NSs). These cover about 11.1% of the total land area for Malawi.

Biodiversity refers to the variety of species, their genetic make-up, and the natural communities in which they occur. Malawi's biodiversity comprises 19 biotic communities mapped at a scale of 1:1,000,000 (Shaxson, 1977). The most dominant vegetation is savannah woodland with *Brachystegia* as the key species. National Parks and Wildlife Reserves together represent 13 biotic communities.

of animal species of which birds are the most diverse, but they are also the most threatened (Table 37). In addition, it is estimated that the country is home to some 1,029 species of amphibians, birds, mammals and reptiles. Out of these species 1.7% are endemic, while 2.4% are endangered. Malawi is also home to at least 3,765 species of vascular plants, of which 1.3% are endemic and 8.9% are protected. Of the tree species, 6 are endangered, while 6 are vulnerable. In 2004, there were 3,765 vascular species of which 49 were endemic and 14 were endangered. Further details about the status of biodiversity, in particular large mammals in selected PA are given in Annex 7 and Annex 8.

Table 37: Status of Animal Species Diversity in Malawi.

Type of Species	*Status of the species*		
	Total Species	*Endemic Species*	*Threatened Species*
Amphibians	56	4	5
Birds	658	3	13
Mammals	207	0	7
Reptiles	108	10	0
Fish	Over 1,000	Not known	Not known
Total	1,029	17	25

Note: This table excludes fish species in many PAs as no data could be accessed. While there are fish resources in some NPs their conservation status has not been documented.

Source: Adapted from http://rainforests.mongabay.com/deforestation/2000/Malawi.htn

5.2 Significance of Wildlife Resources

5.2.1 General

The ecological services provided by biodiversity are vital to everyday life. Yet, wildlife resources and ecosystems in general, and protected areas (PAs) in particular, have long been undervalued, and the contribution of wildlife resources to national output is not reported in official statistics. This can undermine their importance in policy-making processes, and the efficiency and sustainability of PA management.

These areas provide incredible goods and services such as stable soils, as well as reliable and clean supplies of water. Significantly, they hold a wide range of biodiversity including plants and animals, and other organisms essential for aesthetic, cultural, research and educational values. With global concern over climate change, NPs, WRs and NSs will continue serving as carbon sinks, thereby providing a great opportunity in mitigation. From economic viewpoint, the wildlife sector in Malawi is increasingly becoming one of the leading foreign exchange earners. In 2001 the sector contributed approximately 1.8 percent of the country's GDP, which increased to 5.8 percent in a five year period (GoM, 2006).

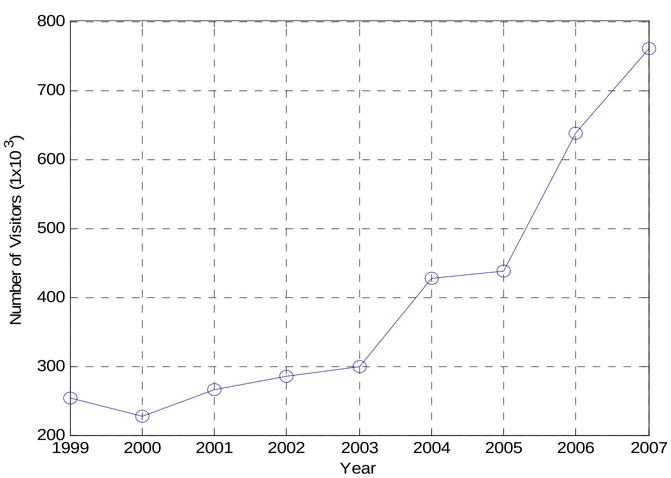
Despite their importance, the role of wildlife resources in the country's economy has not been comprehensively quantified as yet, and this study is an attempt to bridge this gap. However, available data limited our analysis within the constituent elements of the travel and tourism satellite (cf. World Travel & Tourism Council – WTTC, 2009). Similarly, we approached the analysis with selected case studies, but this does not suggest that other PAs are of insignificant value. Regrettably, it is almost impossible to meticulously articulate all the values within the context and scope of the current study.

5.2.2 Tourism

The importance of wildlife resources can be directly linked to the role of the tourism sector globally and nationally. Tourism is of growing economic importance around the World. It is an international business that in 2001 contributed 4.2% to the Gross Domestic Product (GDP) of the global economy and employed 8.2% of the world's economically active population. Thus, tourism is a very important economic catalyst, as visitors spend money directly in hotels and outside of hotels, generating direct and indirect employment and revenues throughout an economy.

In recent years, the tourism sector has received considerable public attention recognising it as a potential contributor to the GDP. For, example, in 2001 the sector contributed approximately 1.8 percent of the country's GDP while in 2007, the figure increased to 5.8 percent. According to the MGDS, this contribution is expected to grow to 8.0 percent by the year 2011 (GoM, 2006). This will come about because of increased government activities targeting the development of the sector and also the expected reduction of tobacco sales arising from the anti-tobacco campaign worldwide. Evidently, tourism visitor numbers in the country are growing (Figure 7). This increase suggests increased foreign exchange earnings and related economic opportunities.

Figure 7: Visitor Numbers from 1999 to 2007[79].



Source: Modified from Various Annual Economic Reports.

[79] Note: Data for the same year presented in this section of the report generally tended to vary in different reports. Efforts were made to use latest reports.

According to the MGDS, the medium term target for tourism is to establish Malawi as a principal and leading eco-tourism destination in Africa. Apart from looking for tourists outside Malawi, there is also an opportunity to increase domestic tourism. According to the World Travel and Tourism Council, tourism is expected to generate 7.1 percent of new jobs annually in Malawi[80].

5.2.3 Employment

In many protected areas wildlife conservation has created job opportunities for the local communities. Using the Majete case study, progress shows that a total of 132 staff from local communities has been employed as fence attendants and general labourers with a total sum of MK2 million (US$14300) being spent on salaries per month. While this can be treated as a cost on the part of managemnt, it is also a benefit to the surounding community.

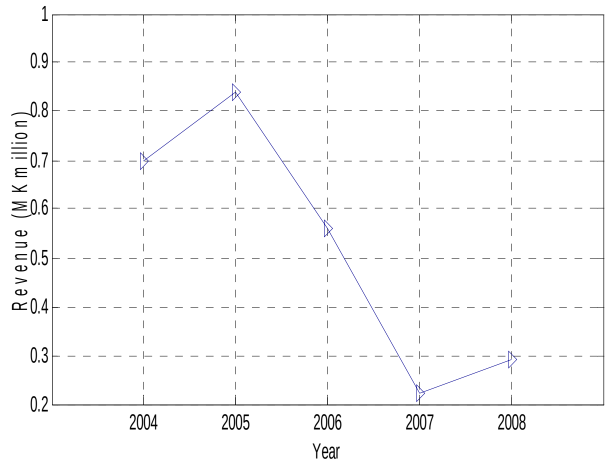
A Community Campsite funded by USAID project (US$15,000) was opened in 2008. The campsite is managed by the local communities themselves through the campsite committee and has employed two people to manage it. The income generated from a total of 138 visitors between January and July 2009 was MK 96, 685 (US$692).

5.2.4 Revenue

The DNPW generates revenue through visitors' utilization of the wildlife resources found in the different protected areas. The revenue is generated from consumptive and non-consumptive uses. Revenue from consumptive use is from sales of trophies, honey and others. Trophies include hippo teeth, skins and meat. Other sources of such revenue are bird licenses, game farming licenses, game ranching licenses and hunting licenses. Figure 7 shows the trends in revenue collected from consumptive uses from 2003/04 to 2007/08 in nominal terms. These figures closely approximate real (rather than nominal) values, as the Malawi kwacha was relatively stable against major foreign currencies during most of this period. Thus, the trend shows that revenue from consumptive sources has declined over time. This trend should not be a cause of concern as it may actually show that levels of abuse and mismanagement as shown by cases of confiscation are actually declining. It could also mean that reported cases have increased without necessarily decreasing incidents of illegal activities in PAs. The trend could also reflect improved livelihoods (hence reduced dependence on Pas) of the surrounding communities, resulting from interventions. For instance, a 3 year project worth US$60,000.00, funded by the USAID started in 2005 to improve livelihoods of people living around Majete WR targeting a population of about 130,000 people in 86 villages.

[80] Ministry of Trade and Private Sector Development, September 2005.

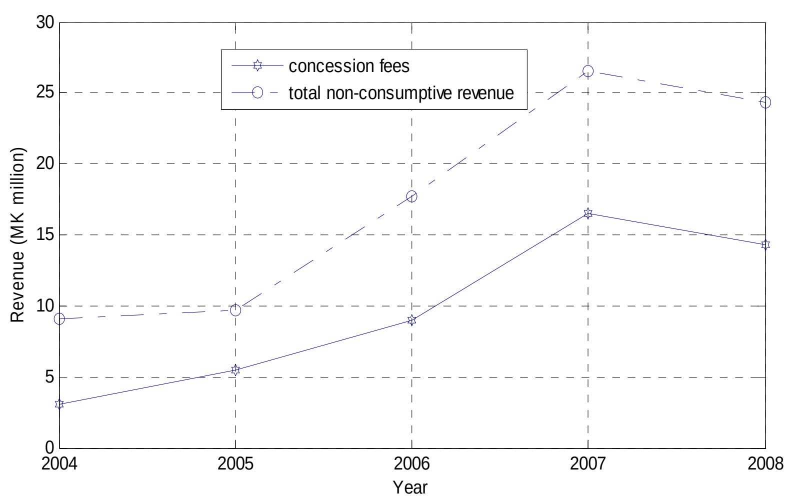
Figure 8: Revenue from Consumptive Uses from 2003-2008.



Source: Various Annual Economic Reports.

Revenue from the non-consumptive uses refer to revenue collected from park entry fees, concession fees, hire of guides, maize mills and tuck shops in the protected areas. Contrasting with the trend in the revenue from the consumptive uses, revenue from non-consumptive uses has been increasing (Figure 9). Evidently, revenue from 2007/08 was less than that of 2006/07 because some concessions that had expired had not yet been either renewed or given to other new operators. Revenue from concession fees as a percent of total revenue from non-consumptive use increased from at least 33% in 2003/04 to about 58% in 2007/08. These are in nominal terms but, as stated above, closely approximate real measures as the Malawi kwacha was quite stable during this period.

Figure 9: Revenue from Non-Consumptive uses in MK million: 2003-2008).



5.3 Threats to Wildlife Resources

5.3.1 Poaching

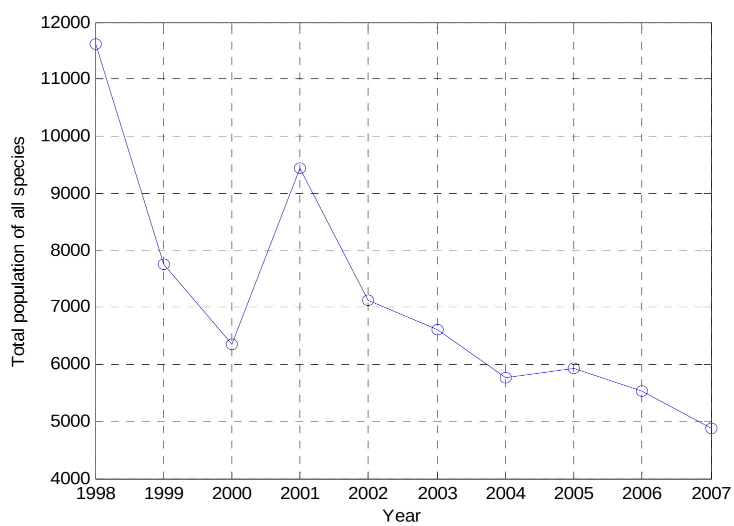
Historically, Malawi's wildlife populations have been fraught with poaching of for food or sale to commercial dealers. Most mammal species such as elephant, buffalo, hippo, lion, eland, hartebeest, roan antelope, nyala and reedbuck have declined considerably over the years in protected areas due to poaching which has affected ecotourism negatively. For example, Majete Wildlife Reserve lost its entire elephant population over the period from 1986 to 1992. In 1989, the elephant population was estimated at 350 (Sherry, 1989) and by 1992 the entire elephant population had been wiped out. By 2003, most of the animal species in Majete had been wiped out through poaching. Restocking plans started after the Government through the Department of National Parks entered into a management concession with a private company to manage the reserve. From 2003 to 2009, a total of over 2,900 animals of different species have been re-introduced into the reserve (Table A8 in Annex7). Currently the elephant population is estimated at 217.

In Kasungu National Park, the elephant population was approximately 2,900 in 1978, but reduced to 200 animals in 2003 due to poaching. In Nyika National Park, eland and reedbuck populations reduced to 523 and 658 respectively in 2002 from 1,203 and 2,184 animals in 1992.

Kasungu NP was once a safe haven for elephants which now exist in insignificant numbers as a result of poaching. This was exacerbated owing to sharing borders with Zambia whose side is not a PA. Thus, the poaching problem in Kasungu NP became a trans-boundary issue and very difficult to deal with. Fortunately, to curb cross border poaching, there are now efforts to manage the entities together under the transfrontier conservation area (TCA) arrangements. In this case, wildlife on both sides of the borders can be jointly managed. The successes of these initiatives with the context of Malawi and Zambia are yet to be observed.

However, even NPs far from borders, such as Liwonde, have equally experienced unprecedented levels of poaching. Consequently, in Malawi, the interactive effects of increasing human population and poaching pressures, agricultural expansion and settlement, amongst others, have led to some animal species such as the Nyassa Wildebeest, Black Rhino, Cheetah and Wild dog become extinct. The levels of poaching are highly variable from one PA to another. However, in our study we show the seriousness of the problem with an example from Lengwe NP (Figure 10). The total number here refers to the sum of all species in the park. Overall, total animal numbers in Lengwe NP is declining.

Figure 10: Trend in Animal Population for Lengwe NP



The declining trend in animal numbers displayed here is worrying for two important reasons. First, it jeopardizes the future of ecotourism development in the country as this relies on the wildlife resources. Secondly, education and research in the field of ecosystem will be hampered. The loss in biodiversity has the potential to curtail future scientific discoveries important in medicine and agriculture. Apparently, there is documentation in the literature to suggest that the animal population decline is attributed to the interactive effects of poaching and climate change as discussed below (Mkanda, 1996; Kazembe, 2009).

Related to poaching is the threat of wild fires. Illegal fires set by poachers destroy wildlife habitats and kill animals.

5.3.2 The Effects of Climate Change

There is consensus that the predicted rate of man-induced global warming of the order of 0.5^{o} C per decade, with estimates ranging between 0.1^{o} C and 0.8^{o} C, will adversely have serious impacts on wildlife and many types of natural ecosystems (Magadza, 1991; Kawasaki, 1991). Kazembe (2009) argues that Malawi's protected areas are generally vulnerable to climate change. This conclusion is deduced based on the following principles:

(a) Ecosystems already stressed by human activities will be more vulnerable to climatic threats and among the first to show the effects of climate change. However, the multiple factors affecting these ecosystems will complicate the identification of strictly climatic effects.

(b) Species adaptation abilities depend not only on genetic variability but also on dispersal and migration capacity. Genetic variability within populations and ecosystems is being reduced through habitat fragmentation. It will be further reduced by pressures resulting from human-induced climate forcing at any level.

Mkanda (1996) indicated that all ungulates in Lengwe National Park would be vulnerable to climate change. Scenarios of future precipitation and ambient temperature were used to evaluate habitat suitability of 5 key ungulate populations. It was concluded that nyala in particular could be highly susceptible due to impacts on habitat and food supply. Documentation indicates that a mini die-off of about 100 nyala occurred in 1980 due to heat and stress caused by drought of the 1979/1980 period (Mkanda, *et al.* 1990). It was reported that the National Fauna Preservation Society (NFPS), now Wildlife and Environmental Society of Malawi (WESM) estimated the nyala population then to be 3,318, one of the highest in the park. A combination of this high population and low rainfall in that year recorded as 447 mm led to unsatisfactory range conditions that caused the die-off. Better rains of 1980/81 (762 mm) and 1981/82 (645 mm) caused the habitat to recover and hence the park was able to support a higher population.

Thus**,** climate change in general presents new conservation challenges and exacerbates current conservation threats. Threats to protected areas mostly include all activities of human or natural origin that cause significant change to park resources, or are in serious conflict with the objectives of park management. Local threats to protected areas in Malawi mostly arise from unsustainable exploitation through hunting, encroachment, fire, logging and a combination of these with climate change.

5.3.3 Encroachment

The establishment of Malawi's protected areas has been the predominant strategy for preserving the country's biological diversity. However many, especially the local subsistence farmers, see protected areas as a threat and government-imposed restriction on their livelihood and access to what they felt as free resources. As increasing numbers of people fail to meet their basic needs from agriculture, they turn to these previously free resources to support their increasingly slim livelihoods.

Requests for the formal excision of land from some protected areas are on the increase and about about sixty km² has been lost to encroachment (Government of Malawi, 2007). Apart from the general shortages of land and resources, the motivation for such requests has been the failure of people to receive either adequate benefits or employment from PAs. This maintains an established negative attitude towards protected areas, except as a source of illegal wildlife products. In Lengwe National Park about 3769 hectares of the park has been encroached by local communities mostly for cultivation. In Vwaza Wildlife Reserve, there is a settlement on the Zambia side before Lundazi. Kasungu National Park is also on the border with Lusukuzi in Zambia. Nyika National Park is bordered with Nyika National Park of Zambia. Because of cross border poaching there are now efforts to manage the entities together under transfrontier conservation area (TCA) arrangements. In this case, wildlife on both sides of the border will be jointly protected from poaching.

5.3.4 General Constraints to Effective Management of Wildlife Resources

In general, a study by Alvarez (2006) indicated that the Protected Areas experienced the following constraints:

- Inadequate staff capacities (skills, experience and numbers).
- The number of scouts was lower than the required number leading to some areas not being adequately patrolled.
- Inadequate financial resources and field equipment (boots, radios, rain coats, torches, cooking utensils, water containers and GPS).
- Inadequate and poor management and eco-tourism infrastructure in PAs
- Weak participation by the local population, particularly in terms of: ownership, employment, investment opportunities and professional skills enhancement
- Weak linkages and collaboration between DNPW with other Ministries, private sector, donor or aid agencies;
- Lack of aggressive marketing of wildlife resources and their products.

5.4 Analysing the Costs and Benefits of Wildlife Resources

5.4.1 Analytical Limitations

We reiterate the argument that placing monetary values on the benefits derived from protection faces a wide variety of data limitations to display everything from personal gains (market values of animals caught or plant products collected) to social benefits (Dixon & Sherman, 1990). Moreover, approaches to valuation would vary according to the kind of benefits under consideration. For example, travel-cost survey can be useful in estimating consumer's surplus from tourism. Hydrologic benefits can be estimated if data on affected downstream areas are available. On the other hand, educational or research values from PAs are much harder to determine although expenditures can be measured.

Malawi's protected areas make considerable contribution to the economy in many different. These are analysed as follows:

5.4.2 The value of Lengwe Wildlife Resources

Case study data produced for this study revealed the huge asset values of Malawi's national parks. Just one of the five national parks, Lengwe was estimated to hold a stock of wildlife valued at US$17.7 million (MK2.5 billion) on the basis of current market prices for live animals. However, all the animal numbers were below the required maximum carrying capacity of the park. Based on the park restocking plan, and animal carrying capacities with the re-introduction and restocking of animal species such as elephant, black rhino, zebra, roan antelope, sable, hartebeest, wildebeest, lion, and cheetah, the economic value of the animals in Lengwe NP would rise to approximately MK11.2 billion (US$80 million).

5.4.3 Estimating the Contribution of the Wildlife Resources to GDP

The contribution of the tourism and travel industry to GDP in Malawi has already been noted, but to date the key role of wildlife (and the ecosystems that support this) is not quantified. We addressed this gap by analysing the constituent elements of the travel and tourism satellite accounts for Malawi prepared by the World Travel and Tourism Council – WTTC (2009), as summarised in Table 38. Using the data in Table 38 together with the World Bank figure for 2007 GDP, we derived the estimates in Table 39 below. These show that the overseas visitor component of travel and tourism in Malawi accounted for 2.7% of total GDP in 2007. As overseas visitors to Malawi are drawn primarily by Malawi's natural capital (and wildlife in particular) we argue that the 2.7% of GDP share can be considered to reflect "nature-based" tourism. That is to say roughly half of Malawi's total travel and tourism spend is accounted for by overseas visitors undertaking nature-based tourism. It is true that some foreign visitors will be visiting relatives or for business reasons but this is likely to be offset by domestic nature-based tourism[81].

Table 38: Travel & Tourism Satellite Accounts

Travel & Tourism - US$ mn	2004	2005	2006	2007
Personal Travel & Tourism	49.4	62.3	64.3	71.0
Business Travel & Tourism	85.0	117.5	132.7	150.9
Corporate	74.6	103.2	117.0	133.3
Government	10.4	14.3	15.7	17.7
Government Expenditures - Individual	1.3	1.4	1.4	1.7
Visitor Exports	36.0	43.0	43.0	48.0
Travel & Tourism Consumption	171.7	224.2	241.3	271.6
Government Expenditures - Collective	2.9	3.2	3.3	3.8
Capital Investment	8.3	9.0	9.2	10.3
Other Exports	18.0	22.3	25.8	31.6
Travel & Tourism Demand	200.8	258.6	279.6	317.4
Travel & Tourism Direct Industry				
Employment ('000)	60.8	79.2	81.6	83.1
Gross Domestic Product	53.4	74.3	80.5	91.2
Travel & Tourism Economy				
Employment ('000)	124.1	158.0	162.7	167.6
Gross Domestic Product	107.3	146.3	158.3	181.4

[81] It is not possible to separate domestic nature-based tourism from other national and international non-business travel by Malawian citizens although we understand that international travel makes up the bulk of this category. Source: WTTC (2009).

Table 39: Estimates of the Contribution of Wildlife-Based Tourism to the GDP

		Key to calculation
GDP (2007) US$ Million	3561	
Share of visitor exports in total direct industry GDP	1.3%	A
Share of direct industry GDP in total GDP	2.6%	B
Share of total industry GDP in total GDP	5.1%	C
Multiplier of direct to total industry GDP	1.99	D = C/B
Implied share of visitor exports in total GDP	2.7%	A x D

5.4.4 Estimating the Cost of Unsustainable Wildlife Use

Methodologically, we estimated the cost of unsustainable use (poaching) by considering the change over time in animal stocks, instead of the total stock level available. The ideal approach would involve economic analyses of the total vegetation and animal biomass for the main species in each PA. While poaching remains the most serious management issue, uncontrolled fires destroy wildlife habitats and at times kill animals. Unfortunately, data on impacts of fires are scanty. Our case studies covered detailed estimates of poaching losses for 1984 – 2003 based on available data for the Majete WR and Lengwe NP, and we used these data sets to estimate indicative figures per square kilometre for the other PAs.

In order to estimate the cost of unsustainable use we would need to consider how the stock of animals changes rather than the total stock level. We did not have data on population dynamics for the main species in each park/reserve but as stock levels were well below carrying capacities (even after encroachment) it was reasonable to assume that natural animal losses would be offset by births. The principal cause of net wildlife loss in Malawi over a number of years would, therefore, be from poaching. Detailed estimates of poaching losses for 1984 – 2003 were only available for one resource (Majete) and we used these to estimate **indicative** figures for Malawi as follows:

- The total cost of animals poached over the 20 year period was calculated in 2008 prices.
- The annual cost due to poaching per square kilometre of Majete was calculated.
- This was extrapolated to the eight other national parks and reserves with large mammals (excluding Lake Malawi NP).

These indicative figures are shown in

Table 40 below. They suggest that average annual economic losses due to poaching are in the order of MK 1.2 billion (US$8.4 million).

Table 40: Indicative Estimates of the Cost of Unsustainable Wildlife Use

Protected Area	*km²*	*Poaching loss at 2008 prices 1984-2003 (US$)*
Majete WR	689	10,905,000
Nyika NP	3,200	50,647,314.95
Kasungu NP	2100	33,237,300.43
Lengwe NP	887	14,038,802.61
Liwonde NP	580	9,179,825.83
Mwabvi WR	350	5,539,550.07
Vwaza WR	1000	1,5827,285.92
Nkhotakota WR	1800	28,489,114.65
Total	10,606	167,864,194.48
	MK	*US$*
Inferred total annual cost	1,225,286,091	8,393,210
As % of 2007 GDP	0.24%	0.24%
Discounted annual cost	5,033,868,695	34,482,001
As % of 2007 GDP	0.97%	0.97%

5.5 Policy Framework and Activities

5.5.1 Overview

Increased threats to biodiversity conservation in the country suggests that, more than ever before, wildlife resources need improved protection in order to ensure their survival for the future. Considerable efforts are made towards maintaining Malawi's wildlife resources. To begin with, Malawi is a signatory to the Convention in International Trade in Endangered Species (CITES) since 1982. However, Malawi still holds a reservation against listing of its elephant population in Appendix I of CITES, which bans all trade in elephants or their parts. Malawi is doing so in order to allow for disposal of ivory once confiscated. In addition, the Department of National Parks and Wildlife (DNPW), is making concerted efforts in its policy to:

- Develop frameworks and strategies whereby neighbouring communities can participate in, and tangibly benefit from, the management and sustainable use of natural and cultural resources that occur in PAs.
- Strengthen all components of wildlife management to bring about sustainability and added value to wildlife resources.

Against these efforts, valuation of wildlife resources in the country will enhance appreciation of their true values by various stakeholders. This is an important step towards realisation of the DNPW's goals as it will eventually garner more technical and financial support for effective management.

5.5.2 Wildlife Policy and Activities

The Malawi Wildlife Policy (2000) advocates the involvement of stakeholders in the management of resources. These stakeholders include local people and the private sector. Thus, unlike in the past, there is increased involvement of the local communities and the private sector in the management of the parks and wildlife reserves. The private sector is largely involved in the running of camps and lodges on concession bases. In return, the concessionaires pay to government part of their revenue for running the lodges. Part of the revenue generated is shared with the community to fund projects of their choice on 50:50 revenue sharing bases. However, the revenue sharing scheme was only piloted in Nyika-Vwaza.

Four activities are being implemented since the year 2008, as follows:

- *Promotion of Ecotourism* **-** Ecotourism is nature-based tourism. As a way of promoting ecotourism, the government is planning to build a lodge at Vwaza Wildlife Reserve, and a conference center at Lengwe's Nyala Lodge. The Department is also in the process of developing a comprehensive Ecotourism Development and Marketing Plan.

- *Restocking Project* - This project is aimed at restocking protected areas that are depleted from areas with excess wildlife. Excess animals have been relocated from Liwonde National Park to Majete Wildlife Reserve. In 2009, 83 elephants were relocated from Mangochi to Majete. The success of these initiatives is contingent on a comprehensive understanding of the many interactive factors which drive depletion of the resources in specific areas of concern.

- *Infrastructural Development* - The Department is building staff houses, roads to protected area and also to improve access to safe water in the protected area. This is aimed at improving the welfare of the members of staff. Staff motivation should remain one of the key strategic goals to ensure their commitment to conservation.

- *Electric Solar Fencing* - This fencing is aimed at protecting the people from dangerous wildlife. The following parks are involved: Liwonde National Park, Kasungu National Park and Vwaza Wildlife Reserve.

The Wildlife Policy, and the National Parks and Wildlife (Amended) Act 2004 present the opportunity for community involvement and participation in the management of wildlife on customary land and open areas like wetlands. This stronger orientation to the involvement of people, user groups, in the natural resources management policies sets the stage for the creation of Community Conservation Areas (CCAs) and Wildlife Management Authorities (WMAs). This is also in line with the Malawi National Environment Policy which calls for the involvement of the private sector, NGO and community based organizations in the protection, conservation, management and sustainable utilization of Malawi's natural resources and community based management and revenue sharing. Some examples include the Kuti Community Wildlife Ranch in Salima and the Lake Chilwa Mwayi wa Mbalame Association among others.

The Wildlife and Environmental Society of Malawi (WESM) is an organization aimed at promoting the management of wildlife in Malawi especially through education. Currently WESM has plans to manage a World Bank sponsored project in Nkhotakota Wildlife Reserve whose main focus will be community education. By educating the community, it is expected that attitude towards wildlife will improve and eventually communities will be able to support wildlife management. In turn this is expected to build animal population as a result of reduced levels of poaching.

5.5.3 Tourism Policy and Strategies

Government has plans to work closely with the private sector to strategically diversify tourism products, identify niche opportunities, and make Malawi's tourist destinations a good value proposition against competitors in the region. According to the MGDS, in an attempt to improve the wildlife sector, the main strategies include:

- Development of quality and diversified products and services based on the natural and cultural resource heritage to attract more tourists;
- Increase in accommodation facilities that are competitive with other tourist destinations in the region, including transportation links to tourism destinations in order to serve additional tourists;
- Improvement in the reach of tourism products to domestic, regional and international markets; and
- Facilitation of investment, infrastructure development and visitor management programmes in undeveloped areas which have proven tourism potential.

Private sector investment in tourism will be encouraged for growth in tourism and government will provide an environment conducive to tourism investment. To facilitate this, the key priorities for Government will be to develop eco–tourism products to acceptable standards, to prioritise roads and landing strips to key destinations, build capacity of communities in tourism through tailor-made courses in training institutions and coordinate efforts for a unified position on tourism promotion to reach potential customers in international and regional markets. As a means to attract investors to put up new infrastructure and equipment, the ministry responsible for Wildlife and Tourism intends to offer incentives by creating an enabling environment for outside tour operators who would have duties waived for a specific period.

In order to promote high standards in the tourism sector, the government will launch a campaign that will help all unofficial tour guides to follow standardized procedures in their operations. The Ministry has a website (http://tourismmalawi.com), intended to provide the base for a tourism market at home and abroad as part of creating publicity and increasing the marketing strategy. The government reviewed the Tourism Master Plan which will among other things introduce hotel grading system and step up participation at international business forums and travel exhibitions to attract both investors and tourists to Malawi. Marketing efforts have been intensified in major international source markets including the United Kingdom, Germany and the Netherlands. A major upgrading of facilities in the national parks and access to them has been underway to ensure that the number of international standard hotels is increased throughout the country.

Within the Tourism Master Plan, the government identified five places for eco-tourism development. These are Nkhotakota Wildlife Reserve, Mount Mulanje, Kapichira Falls, the area between Lake Malawi and Lake Malombe in Mangochi District, and Cape Maclear. Nkhotakota Wildlife Reserve is the largest reserve which is inhabited by elephants. Mount Mulanje is the highest mountain offering some hiking and trekking trails. Kapichira Falls is ideal for bird watching and has also animals such as elephants and other mammals. The lakeshore areas between Lake Malawi and Malombe have a chain of holiday resorts and therefore the popular attraction can be further improved. The Cape Maclear area on the Namkumba Peninsula was selected because of the cichlids which are endemic to Malawi.

5.6 Conclusion and Recommendations

Wildlife resources in Malawi are obviously valuable. However, given data limitations, their true value is too complex to exhaustively present in this study. Comprehensive cost-benefit analyses, covering all PAs over a longer period are needed. Focusing only on the extractive or commercial values of wild species and natural ecosystems has meant that PAs have been undervalued. Notwithstanding, it is indisputable that easy access areas especially national parks which have visitor facilities provide a variety of recreational and amenity benefits to both local and foreign visitors. More importantly, the ecosystems in PAs provide important biological and hydrological benefits. For that reason, in our examination of the costs and benefits of management of PAs, the key issue is not whether or not their benefits justify the maintenance of their protection status. The real question of interest is: What level of expenditure on improved management is justified given the benefits that PAs provide against the threats such as poaching, climate change, uncontrolled fires and illegal settlements?

The current study makes the following recommendations:

a) The DNPW is pursuing a comprehensive policy which embraces stakeholder engagement and participation as an important tool for effective management of PAs in the country. However, urgent implementation of this policy with tangible benefits accruing to local communities cannot be overemphasized. The DNPW should extend execution of the benefit sharing scheme which has been pioneered in Nyika National Park to other protected areas.

b) Many NPs and WRs are still undeveloped in terms of ecotourism infrastructures. All weather roads, accommodation and visitor information centers are needed to facilitate growth of ecotourism in PAs.

c) Wildlife populations in most protected areas, especially where management is inadequate, are declining at a rate unmatched with current levels of human and financial resources. If the benefits of wildlife resources are to be maintained the key management issue is developing a more protective scheme. To do this requires an integrated program involving community education, development of alternative sources of supplemental income for local communities adjacent to the PAs and well planed and stricter law enforcement. This seems to be in place but needs scaling up.

d) The restocking program initiated by the DNPW is commendable and desirable for ecotourism development, as it will restore the PAs which have been depleted of their resources. However, restocking will only be successful if coupled with increased law enforcement and educating the local communities about the need for involvement in management.

e) Further research is needed to determine the impacts of climate change on wildlife. Currently, it is only Lengwe National Park that has received attention on this issue. The DNPW should develop research agenda to involve universities in the country to further understand the impacts on climate change on wildlife resources and ultimately on nature-based tourism. The meteorological stations in PAs should be revived in order to monitor the effects of climate change.

6. The Economic Significance of Natural Resources in Malawi

6.1 Valuing the Macro-Economic Contribution of Natural Resources

The economic contribution made by renewable natural resources to Malawi is very significant but is not adequately captured in official statistics. Part of the problem lies with how national income is measured. For instance, estimates of GDP do not record the contribution of soils or wildlife. When soil erosion causes hydro-electric power losses considerable analytical work is therefore required to attribute the resulting economic cost to the failure to maintain soils.

Even where natural resource use is recorded in GDP (as with forestry and fisheries) this value tends to be understated. In Malawi official GDP figures significantly understate the true contribution of forestry by not capturing the extensive use of wood for fuel, for example.

In this study these valuation issues were addressed as follows:

1. Making use of detailed recently published studies of the forestry and tourism sectors in Malawi we produced revised estimates of GDP contributions by NR sectors.
2. Using primary research undertaken for this project as well as existing data we identified the economic cost of soil degradation on agriculture and the impact on hydro-electric power production as well as net loss of forest resources and costs of indoor air pollution in Malawi. The economic cost of unsustainable fishing was estimated by comparing the returns of more and less sustainable fishing practices and indicative costs of wildlife poaching were extrapolated from a detailed study of one park.
3. Finally, we calculated adjusted net savings for Malawi – a measure of national wealth that incorporates natural resource use.

6.2 Contribution of Renewable Natural Resources to GDP

Table 41 below summarises the contribution of forestry, fisheries and wildlife to GDP in official statistics, and compares them with estimates based on recently published specialist studies.

Table 41: Contribution of NR Sectors to GDP

NR Sector	*Official Statistics*	*Additional contribution identified*	*Total share of GDP identified*	*Sources of additional evidence*
Forestry	1.8%	4.3%	6.1%	Best (2009) – charcoal & firewood
Fisheries	4.0%	-	4%	
Wildlife	-	2.7%	2.7%	WTTC (2009) – nature-based tourism
Total	5.8%	7.0%	12.8%	

Even when viewed through the narrow prism of GDP statistics, the contribution of renewable natural resources is striking. The large contribution of charcoal and firewood is omitted in official statistics. In contrast, the contribution of the tourism and travel industry is included but the key role of wildlife (and the ecosystems that support this) is not quantified. By analysing the constituent elements of the travel and tourism satellite accounts for Malawi prepared by the World Travel and Tourism Council – WTTC (2009) – we conclude that nature-based tourism contributes around 2.7% of total GDP. Thus, roughly half of Malawi's total travel and tourism earnings are accounted for by overseas visitors undertaking nature-based tourism.

6.3 The Macro-Economic Cost of Unsustainable Natural Resource Use

Table 42 summarises our base case estimates of the cost of unsustainable natural resource use and the source of these costs for each NR sector. Details of the calculations can be found in the Chapters on each NR sector. As we were very conservative when producing these estimates, they almost certainly underestimate total economic costs.

Malawi pays a very high price for unsustainable natural resource use. This cost is equivalent to giving up 5.3% of GDP each year. To put this in context, the MGDS aims for *total* annual GDP growth of 6%. Malawi would be richer by MK26.6 billion (US$191 million) each year in 2007 prices if soil, forest, fishery and wildlife resources were used sustainably. This is more than the total funding allocated to the Ministry of Education Science and Technology national budget for 2009/10 (MK24.5 billion or US$175.3 million), and even more than that allocated to the Ministry of Health in that year (MK22.9 billion or US$163.6 million).

Table 42: Economic Costs of Unsustainable Natural Resource Use

NR sector & source of cost – base case	*Annual cost (2007 prices)*			*Discounted cost of damage over 10 years*	
	MK Million	*US$ Million*	*% of GDP*	*MK Million*	*% of GDP*
Soils:	**8,988**	**65**	**1.9%**	**40,665**	**8.2%**
On-site impact on agriculture	7,540	54	1.6%	30,915	6.3%
Off-site impact on hydropower	1,433	10	0.3%	9,688	1.9%
Off-site drinking water treatment	15	0	0.0%	62	0.0%
Forests:	**12,983**	**93**	**2.4%**	**31,795**	**11.0%**
Unsustainable roundwood (excl fuelwood)	3,100	22	0.4%	12,710	2.4%
Unsustainable fuelwood	6,089	44	1.2%	2,495	4.8%
Flood prevention (indicative only)	232	2	0.2%	1,987	0.8%
Indoor air pollution	3267	23	0.7%	13,394	2.7%
Outdoor air pollution - WB 2002	**327**	**2**	**0.2%**	**2,417**	**0.5%**
Fisheries:	**3,906**	**28**	**0.8%**	**7,666**	**1.5%**
Unsustainable use (lower bound)	3,906	28	0.8%	7,666	1.5%
Wildlife:	**665**	**5**	**0.1%**	**2,730**	**0.5%**
Poaching loss (indicative only)	665	5	0.1%	2,730	0.5%
Total	**26,573**	**191**	**5.3%**	**84,064**	**21.4%**

Over time the costs of unsustainable resource use mount up. With a 10% discount rate, the discounted value of unsustainable natural resource use over a decade would amount to more than

MK84 billion (US$600 million) in 2007 prices – approximately MK28,000 (US$200) for each household in Malawi.

The largest costs result from the loss of agricultural productivity as a result of soil degradation, deforestation in catchments around the main urban centres to supply firewood and charcoal, unsustainable fishing and reduced economic activity caused by indoor air pollution.

There is compelling evidence that unsustainable natural resource use leads to increased poverty in Malawi. For instance, World Bank data from 1992 indicated an average annual agricultural yield loss of 4% – 11% as a result of soil erosion, while Bishop (1995) estimated mean annual yield losses of 8% – 25%. To understand what this implies for poverty, we can draw on the work of Benin et al (2008) who use a Computable General Equilibrium model to investigate the impact of higher agricultural yields and consequent economic growth on poverty in Malawi. This captures the direct effect of agricultural yields on farmer income, but also the indirect benefits obtained by urban consumers (effectively increased real income) from an increasing food supply. They forecast that achieving a 6% growth in agricultural yields during 2005-2015, would increase overall GDP growth from 3.2% to 4.8% per year leading to the proportion in poverty falling to 34.5% by 2015, which is considerably lower than the 47.0% poverty rate projected in the absence of the additional agricultural growth. The 6% agricultural yield growth results in an additional 1.88 million people being lifted above the poverty line by 2015.

The on-site impact on agriculture of soil degradation in Table 42 *alone* corresponds to losing 6% of agricultural yields. Solving this problem would therefore remove 1.88 million people from poverty over a decade, following the logic of Benin et al (2008). However, if *all* the lost economic value from unsustainable resource use each year in Table 42 was converted into economic growth, the impact on poverty would be much larger. If this had been done over the period 2004 – 2015, the proportion in poverty would be halved from its 1990 level – to about 25%. This is the basis of the MDG1 scenario modelled by Benin et al (2008) in which GDP growth was 4.2% per annum above the baseline case (7.4% rather than 3.2% yearly). Clearly this is no longer achievable by 2015, but it serves to illustrate the enormous potential for poverty reduction that more sustainable natural resource use could have.

6.4 Unsustainable Natural Resource Use and Adjusted Net Savings

If forest, fisheries and soil nutrient resources are used up faster than they are replenished, Malawi is consuming her natural capital. Adjusted Net Savings (ANS, sometimes known as genuine savings) is a green accounting measure that takes this measure of natural capital as well as health damaging air pollution into account, alongside the standard measures of physical and financial savings. Human capital formation (spending on education) is added as an investment in the ANS calculation so that, overall, it provides a holistic measure of national wealth.

The World Bank estimated ANS for 2006 for Malawi to be 12.24% of Gross National Investment (GNI), indicating that national wealth was increasing. However, this estimate excludes the latest evidence on deforestation from woodfuel use, the cost of soil nutrient losses, estimates of the costs of indoor air pollution or any estimates for the fisheries or wildlife sub-sectors. By including these items (from Table 42 deflated to 2006 prices) we found that the country's ANS for 2006 falls to 7.14% of GNI (see Table 43). What is particularly troubling is that the contribution to national wealth from educating the nation is outweighed by the loss of wealth from natural resources degradation.

Table 43: Adjusted Net Savings for Malawi

	WB (2006) % of GNI	*WB/Authors % of GNI*
Gross National Saving (various methods used)	15.69	15.69
- Consumption of Fixed Capital	7.30	7.30
= Net National Saving	8.39	8.39
- Education Expenditure	4.87	4.87
- Energy Depletion	0.00	0.00
- Mineral Depletion	0.00	0.00[82]
- Net Forest Depletion	0.64	2.05
- Soil Erosion		2.01
- Fishery depletion (lower bound)		0.87
- Wildlife depletion (indicative)		0.15
- CO_2 damage	0.22	0.22
- PM10 damage (Outdoor air pollution WB 2002)	0.16	0.16
- Indoor air pollution		0.66
= Adjusted Net Saving	12.24	7.14

[82] MK0.1 million

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Mr. H. Utila, Forestry Research Institute of Malawi

Mr. J. Nagoli, Senior Research Analyst, WorldFish Center, Domasi

Mr. K. Chirambo, Assistant Deputy Director (Training and Planning), Department of Forestry

Mr. M. Makuwira, Chief Planning Officer, Department of Fisheries

Mr. M. Manda, Deputy Director, Land Resource Conservation Department

Mr. P. Jere, Consultant

Mr. T. Zulu, Deputy Programme Manager Improved Forest Management for Sustainable Livelihood Programme

Mr. W. Mitembe, Principal Forest Officer (Planning), Department of Forestry

Annex 2: Forestry Policy and Legislation

The current National Forestry Policy was formulated in 1996, to promote the participation of all stakeholders in the restoration, conservation, management and utilisation of forestry resources. The policy, as enhanced by its supplement of 2003, targets the participation of such stakeholders as local and rural communities, the private sector and non-governmental organisations in tree planting and other management activities. At the rural community level, one of the outcomes of this initiative has been the establishment of village natural resource management committees, which are trained to take responsibility for the management of local resources. This policy initiative represents a major shift from the spirit of the outdated Forestry Act of 1942, which gave more powers and responsibility for management of forestry resources to the Forestry Department, and did not provide for the management of forestry resources on customary land.

In order to define and enforce interventions aimed at the sustainable management of forestry resources, the Forestry Act was passed in 1997, to replace the one passed in 1942. The act provides for the manning of roadblocks and enhanced patrols by forestry staff to bring offenders to book. It also provides the legal framework for the management of indigenous forests on customary and private land, the management of reserves and protected areas, as well as the establishment and management of woodlots and plantations.

To enhance the objectives of the 1996 policy and the 1997 law, the Department of Forestry launched the Malawi National Forestry Programme in 2001, and produced the 'Standards and Guidelines for Participatory Forestry in Malawi' in 2005. The latter seeks to guide the promotion of community-based management of forestry resources, and to establish standards for extension delivery and improved management.

Until recently, the Department of Forestry was implementing a five-year strategic plan for the sector for the period from 2003 to 2007. An evaluation of the implementation of the strategic plan, which has not yet been conducted, could assess the extent to which its objectives were achieved, and inform the design of a new one which is yet to be formulated. Other important official policy documents of relevance are the following:

- GoM, Ministry of Natural Resources and Environmental Affairs (undated): The National Environmental Action Plan;
- GoM, Ministry of Natural Resources and Environmental Affairs (undated): National Action Programme for Malawi for the United Nations Convention to Combat Desertification;
- GoM, Ministry of Mines, Natural Resources and Environment (2006), Malawi's National Adaptation Programmes of Action (NAPA)
- GoM, Ministry of Energy and Mines (undated): The Five Point Forestry Plan: Tree and Forest Restoration Plan[83].

[83] The Plan is proposed to run from 2009/10 to 2013/14 at a total cost of about MK1.04 billion.

Annex 3: Forestry Sub-Sector Programmes/Projects

Several activities are being carried out in the forestry area, largely focusing on the management, conservation and development of the resources. Most importantly, afforestation programmes are said to have been undertaken in government plantations since 1950, and on community land since the late 1980s (Consortium AGRIFOR Consult, 2006). Three of the key national programmes/projects are as follows:

- The Improved Forest Management for Sustainable Livelihoods Programme (IFMSLP), which is funded by the European Union, aims at 'improving the livelihoods of local communities in twelve districts through the provision of forest goods and services and the development of forest-based enterprises'[84], hence contributing to household incomes and food security.
- The Forestry Replanting and Tree Nursery Project (FOREP), implemented since 2005/06 to address the challenge of deforestation by undertaking tree planting and support management activities, as well as related seed collection and training activities. The project focuses on the rehabilitation of degraded industrial forest plantations. In 2008, the project planted 300 hectares in industrial softwood plantations, and assisted in the management and protection of old plantations (GoM, 2009).
- The Tree Planting and Management for Carbon Sequestration and Other Ecosystem Services (TPMCSOES) Programme, whose broad objective is to promote commercial tree planting and management by farmers. Total funding of MK80 million (US$0.57 million) was provided by the government in 2007/08, and 148 farmers benefited. 580,000 seedlings worth MK2.4 million (US$0.017 million) were purchased and distributed to the farmers, covering 242 hectares. This programme provides direct financial rewards to farmers for participation and proper management of planted trees[85], in order to facilitate Malawi's entry into the global carbon market. However, concerns have been raised regarding the global carbon trading initiatives (see Box A1).

The following additional projects may also be cited (see GoM, 2009:20-21):

- The Community Vitalisation and Afforestation in the Middle Shire (COVAMS) project, a Japanese Government-supported project whose objective is to rehabilitate the watershed of the Middle Shire through tree planting and the promotion of income generation;
- The Lake Malawi Artisanal Fisheries Development Project (Watershed

Box A1 Issues on Carbon Trading

A consultative meeting of the MPEI Technical Committee[86] raised two critical issues on the carbon trading initiative, viz:

- Developing and less developed countries were being urged to keep their forests and create carbon sinks, yet they were being adversely affected by climatic changes arising from the high carbon emissions in developed countries. Hence, carbon trading should be pursued as a justice issue.
- The carbon market project was too complicated to attract the participation of ordinary people. There is need for technical support to communities to develop the projects .

[84] See GoM (2008:24).

[85] In 2006/07, 298 ha were planted with tree by 91 farmers (this translates to 3.2 ha/farmer) who were compensated by some K5.7 million for the area planted and some K3.7 million for the trees that survived (GoM, 2008).

[86] This meeting was convened on 29 May 2009 to discuss a draft version of this report.

Component), a project funded by the African Development Bank (ADB). The Watershed Component seeks to protect and manage the catchment area of the lake through tree planting and the management of indigenous forests.

- Research and Development of Traditional Medicines of Malawi, a project of the Forestry Research Institute of Malawi (FRIM) and the National Research Council of Malawi (NRCM), funded by the National Aids Commission (NAC). It primarily seeks to promote research and development in the use of traditional medicine for the management of HIV and AIDS, and related infections.
- Millennium Seed Bank Project which is supported by KEW Botanical Gardens of the United Kingdom. It seeks to preserve Malawi's indigenous, wild, endemic and/or economically important flowering plant for future use and biodiversity conservation.
- Agro-forestry Food Security Project (AFSP), supported by the Republic of Ireland (Irish Aid). It has the objective of combining "sound science, effective partnership and responsive scaling up approaches with informed policies … " to, among other things, increase fruit tree portfolios (GoM, 2009:21).
- The National Forestry Programme (NFP) Facility, a facility funded by the Food and Agriculture Organisation (FAO) to support national policy formulation in the forestry area. It mainly seeks to integrate sustainable forestry management into poverty reduction strategies, among other objectives.

The private sector and the NGO community are also actively involved in the forestry area. The annual National Tree Planting Season (15 December to 15 April) is at the hub of tree planting achievements across the country. It was estimated that 21,102 and 22,1162 hectares were planted with trees in 2007/08 and 2008/09, respectively. Industrial forest rehabilitations in those years were estimated at 1,400 hectares and 330 hectares. Annual data on tree planting activities at the district level is quite relatively maintained by the Department of Forestry.

Annex 4: Status of Forestry Resources Information and Data

This section discusses some of the key sources of data on forestry resources, and appraises their adequacy. The following main data sources, which could be useful in generating a database for of forestry resources, are discussed:

- The Annual Economic Report;
- The Global FRA 2005 Country Report;
- The State of Malawi Forests 2004; and
- The Forestry Outlook Study for Malawi
- The Malawi Biomass Energy Strategy

4.1 The Annual Economic Report

The Annual Economic Report (AER)[87] compiled by the Ministry of Economic Planning and Development provides useful summary information on the forestry sector, under the chapter on Agriculture and Natural Resources. Table A1 gives a snapshot of the information coverage over the past seven years. It is important to note that the AER for 2005 and 2006 did not include information on forestry, despite such information having been reported in prior years. As such, using the AER alone to construct a basic database would result in data gaps, and would be worsened by the general shallowness of the information provided. It is worth noting, however, that the 2008 and 2009 versions of the AER contain more detailed and useful information in analysing the economic significance of the sector, including time series of other recurrent transactions (ORT) budgetary allocations to the Department of Forestry, as well as forestry employment figures. The 2009 version also includes the impact of HIV/AIDS, as well as small and medium scale forest-based enterprises. However, the more recent issues have been relaxed in terms of presenting time series data on such indicators as number of trees planted as well as incidences and costs of forest fires. These statistics are equally crucial in economic analyses. It is also interesting to note that some of the figures reported in the AER are static, as shown in Table A2, raising questions regarding the reliability of the data.

Table A1: Forest Resources Information Coverage in AERs from 2003 to 2009

Area of Coverage	***AER Issue Covering the Area***
Forestry sector overview	2009, 2008, 2007
Forestry policy and legislation	2009, 2008, 2007, 2004, 2003
Forestry sector employment	2009, 2008
Impact of HIV and AIDS in forestry	2009
Conservation and development of plantations	2009, 2008, 2007, 2004, 2003
Forest utilisation and marketing	2009, 2008, 2007
Incidence of forestry fires	2009, 2008, 2007, 2004, 2003
Management of natural/ indigenous woodlands	2009, 2008, 2007, 2004, 2003
Department of Forestry budgetary allocation	2009, 2008
Department of Forestry revenues	2009, 2008, 2004, 2003
Tree planting and plantation rehabilitation	2009, 2008, 2007
Small and medium forest-based enterprises	2009
Forestry programmes and projects	2009, 2008, 2007, 2004
Forest research	2004

[87] This was called the Economic Report before 2005.

Table A2: Stickiness of Selected Forestry Sector Statistics

Statistic	***AER 2003***	***AER 2008***	***AER 2009***
Formal employment		20,000	20,000
Charcoal industry employment		92,800	92,800
Industrial pine plantations (ha)	74,000	74,000	74,000
Industrial eucalyptus plantations (ha)	23,000	23,000	23,000

4.2 The Global FRA 2005 Country Report

The FAO's Global Forest Assessment 2005 (FRA 2005) report collated forestry resources monitoring information for 229 countries and territories for three dates: 1990, 2000 and 2005. The FRA 2005 Country Report for Malawi is part of this global initiative. Malawi did not nominate a national correspondent for FRA 2005, and did not submit an official report to inform this process. As such, the Malawi assessment is largely based on desk research of quite aged literature, notably the forest resources mapping and biomass assessments undertaken in 1973 and 1991, implemented for the Department of Forestry by Satellitbild (see Department of Forestry, 1993). In the context of these limitations, the status of tables in the Malawi country report is summarised in Table A3.

Table A3: Status of FRA 2005 Tables for Malawi

Table	***Description***	***Status***
T1	Extent of Forest and other Wooded Land	Estimated based on data for 1973 and 1991
T2	Ownership of Forest and other Wooded Land	Only estimated for plantations for 1990, using annual data from 1985 to 1989. No estimates for other resources due to data limitations
T3	Designated Function of Forest and other Wooded Land	2203 of 3896 classified under no or unknown function in 1990. Classification not possible beyond 1990 due to data limitations
T4	Characteristics of Forest and other Wooded Land	Estimated based on data for 1973 and 1991
T5	Growing Stock	Estimated for natural forests based on data for 1991. No estimates for plantations due to data limitations
T6	Biomass Stock	Estimated based on T5 estimates
T7	Carbon Stock	Estimated based on T6 estimates
T8	Disturbances Affecting Health and Vitality	Not estimated due to data limitations
T9	Diversity of Tree Species	Estimated for 2000
T10	Growing Stock Composition	Not estimated due to data limitations
T11	Wood Removal	Estimates based on annual data from 1988 to 2003
T12	Value of Wood Removal	Not estimated due to data limitations
T13	Non-Wood Forest Production Removal	Not estimated due to data limitations
T14	Value of Non-Wood Forest Production Removal	Not estimated due to data limitations
T15	Employment in Forest	Estimated using annual data from 1990 to 2000

4.3 The State of Malawi Forests 2004

The State of Malawi Forests 2004, compiled by the Department of Forestry, is an important source of data at the district level. In general, it contains information on the geographical and demographic characteristics of each district, including:

- Vegetation and forest cover;
- Types, sizes and ownership of forestry resources available;
- Management of the resources;
- Afforestation and re-forestation programmes and activities; and Human resources in the forestry sector.

4.4 The Forestry Outlook Study for Malawi (Kainja, 2000)

Prepared under the auspices of the Forestry Outlook Studies for Africa (FOSA), the study by Kainga (2000) is quite outdated but still an important information source in a sector where information generation is costly and information management is poor. The study collected, reviewed and interpreted the exiting information on the sector. Using such information, it contextualised the status, trends and key activities in the sector. It also placed these in the broader socio-economic context, and discussed their policy implications. Being an old study, the background information therein contained is obviously outdated. Additionally and unsurprisingly, it reflects the obvious data limitations that existed at the time, some of which have not yet been addressed to date. These include the following:

- Although the year of the source of the forest extent is not stated, the total area of forest resources provided (i.e., 3.95ha) could reflect the situation in the 1980s.
- Deforestation rates were entirely based on Landsat data for 1973 and 1991.

4.5 The Malawi Biomass Energy Strategy (Malawi BEST)

Dated April 2009, this is probably the most current and comprehensive source of information on the forestry sector in general, and biomass energy in particular. While most of the focus is on biomass energy, the direct link of this energy source with the forestry sector implies that significant attention has been paid on the forestry sector, and Chapter 2 provides updated information on land use. In addition, the Malawi BEST provides an in-depth coverage of the energy sector: the legal, regulatory and institutional framework, the demand and supply of energy, and recommendations to improve the management of biomass energy resources. Although the study uses sophisticated modelling and projection methodologies, most information is still based on the baseline surveys conducted up to the 1990s, notably by Satellitbild (see Department of Forestry, 1993), for most key variables.

4.6 Other Sources of Information

In addition to the foregoing data sources and studies, additional information on forestry resources is contained in the following documents and reports, among others:

- Kambewa, P. and H. Utila (2008): Malawi's Green Gold: Challenges and opportunities for small and medium enterprises in reducing poverty, International Institute for Environment and Development, London.
- Kambewa, P. et al (2007): Charcoal, the reality: a study of charcoal consumption, trade and production in Malawi, International Institute for Environment and Development, London.
- Consortium AGRIFOR Consult (2006): Country Environmental Profile Malawi, Final Report

- GoM, FRIM[88] (1999): Community-Based Management of Miombo Woodlands in Malawi
- GoM, Department of Forestry: Annual Report (various).
- Mlay et al (undated): Agricultural policies and forestry development in Malawi, Mozambique, Tanzania and Zimbabwe: Complementarities and conflicts.

[88] FRIM is short for Forestry Research Institute of Malawi

Annex 5: Policy and Strategic Initiatives in Fisheries Sub-Sector

5.1 Policy Environment

Malawi has an integrated policy framework guiding developments in fisheries and aquaculture, developed between 2001 and 2003. At the centre of this framework is the recognition of the need to maximise the level of sustainable fish yields from across all water bodies, improve the exploitation, processing and marketing of fish products, and promote investment opportunities in the sector. The framework has, therefore, focused on addressing the deterioration observed in the sector by promoting a more sustainable culture of utilizing the fish resources and enhancing efforts that seek to build alternative channels of increasing stocks available for use by households and for marketing purposes.

The overarching guiding principles for fisheries are enshrined in the National Fisheries and Aquaculture Policy of 2001. The policy has three key aims, as follows:

- to maximise the sustainable yield from the natural and man-made waters;
- to improve efficiency in exploitation, processing and marketing; and
- to promote investment in the industry and the development of new aquatic resources.

Initiatives include the adoption of extension services (a sequel to the agricultural sector extension service), targeting to disseminate fisheries and environmental messages to fishing communities. The policy also seeks to promote fisheries research into problems associated with fisheries amongst communities, and promoting efficiency-oriented techniques, while also creating a conduit for the flow of fisheries information. The following outline gives a comprehensive enumeration of policies and stakeholder institutional efforts impacting developments in the fisheries sector in Malawi.

5.2 Policy and Strategic Frameworks Affecting the Fishing Industry

Since the Department of Fisheries has now been shifted from the Ministry of Natural Resources and Environmental Affairs to the Ministry of Agriculture and Food Security, the policies related to agriculture closely affect the fisheries area. As such the policy and related strategies listed here include those from Fisheries and Agriculture, viz:

a. The National Fisheries and Aquaculture Policy
b. The Chambo Restoration Plan
c. National Aquaculture Strategic Plan
d. The Fisheries Conservation and Management Act
e. International and regional laws conventions and protocols
f. The Convention Concerning the protection of the World Cultural and Natural Heritage
g. The Convention on Biological Diversity and Cartargena Protocol on Biodiversity
h. The Fisheries HIV and AIDS Strategy
i. The Food Policy and the Nutritional Policy
j. The Crop Production Policy
k. The Policy Document on Livestock in Malawi
l. The Agriculture Extension Policy
m. The Agriculture Research Policy
n. The Agriculture Policy Framework

5.3 MGDS and ADP Targets

The above policy and action ideas were synchronised into strategic MGDS and Agricultural Development Programme (ADP) targets by the Department of Fisheries. These are:

a. To increase the quantity of fish landings in capture fisheries from 55,000 metric tonnes to 60,000 metric tonnes by 2011. According to the National Aquaculture Strategic Plan (see GoM, NAST, 2005), the total potential yield is estimated at 78,000 metric tonnes, of which 58,000 metric tonnes would be from Lake Malawi. The total potential yield from deep waters in Lake Malawi is 43,000 metric tonnes. However, the stocks have to be shared with Mozambique and Tanzania. Previous research studies indicate that the maximum sustainable yield of offshore deep water fish stocks in Lake Malawi is estimated at 33,000 tonnes per year. However, recent evidence shows that there are significant declines in potential yield (see Box A2).
b. To increase fish landed in aquaculture from 500 metric tonnes to 5000 metric in 2011. The NASP makes a strong case for the promotion of aquaculture fish production[89].
c. To reduce fish post-harvest losses by 40% by 2011. Information on the current extent and costs of post-harvest losses could not be traced, although poor storage and transportation facilities are among the key factors contributing to such loss.
d. To increase the amount of exported fish to 1000 metric tonnes by 2011.

The targets above show that there is a clear recognition of the need to revamp production levels in capture fisheries and aquaculture. Targeting a conservative increase of just about 5000 metric tonnes in a period of over one year is in itself an indication that, due to the complexities in the factors affecting fisheries, expectations were set modestly. For example, the 2008/09 mid-year review by the department shows that the fisheries policy and act are due for reviews. Moreover, numerous vacant positions exist in the department and, critically, only 41% of the approved recurrent funding has managed to trickle down to the department. Addressing the performance shortfalls already highlighted is hardly likely to succeed unless these constraints are addressed.

Meeting target (a) above is on track (see Section 4 of the report). While some activities aimed at addressing the concerns of the MGDS and aquaculture development were reported to be underway, not much progress could be fathomed at

Box A2: Declining Potential Fish Yield

According to the (LMAFDP, 2009)[90], there are challenges in potential fish yield that are attributable to significant decline in biomass, particularly in shallow waters. Potential yield in shallow waters declined by 61% from 22,914mt in 1999 to 14,242mt in 2007. In deep waters, the decline was only by 8% from 24,887mt in 1999 to 23,158mt in 2007. Biomass estimates of the deep water areas in 2007 were comparable to those of 1999.. In contrast, biomass in shallow water areas within the same period declined by 120% from about 5,430 to 2,270 tonnes. This phenomenon was also observed during the surveys undertaken in 1990s. The high rates of biomass decline in shallow waters reflect heavy fishing pressure exerted by the artisanal fisheries. On the other hand, the fish resources in the deep waters (>50m) have not changed with time.

This information suggests that most of the important commercial fish stocks are presently over-exploited in the shallow waters.

[89] In particular, NASP supports the promotion of aquaculture on the basis that (a) it has major advantages over cash crops, because fish is a high-value product with a ready market, (b) it promotes better utilisation of land, (c) it diversifies farm incomes, (d) it stabilises the livelihoods of the poor and improves their nutrition, and (e) capture fishery cannot need current demand even if resources were sustainably utilised.

[90] This information was supplied by The Lake Malawi Artisanal Fisheries Development Project on request.

this point. Aquaculture initiatives were reported to have reached a maximum of 2000 metric tonnes out of the 5000 tonnes being targeted. Reviews of the act and the policy have been started, capacity building, such as training of staff and farmers in fish farming techniques, licensing of small scale farmers as well as awareness campaigns for the fisheries legislation were also reportedly on track. Institutional building such as the formation of village beach committees, census for farmers and setting up of working arrangements for the community groups were on track, too. However, the capacity for the Fisheries Department to facilitate these initiatives is below expectations due to staff shortages, lack of appropriate equipment, limited technical expertise and budgetary constraints. These limitations have been responsible for failure to meet the annual targets. For example, policy review has overflowed from one year to another on account of shortage of funding and expertise.

Unlike in forestry, there is no elaborate structure for the collection of royalties and fees from fishing activities.

5.4 The Chambo Restoration Strategic Plan 2003 - 2015

The Chambo Restoration Strategic Plan (CRSP) for 2003-2015 was an off-shoot of the Department of Fisheries Sector Investment Program within the precincts of the National Strategy for Sustainable Development and the Poverty Reduction Strategy. Considering that Chambo is the most popular specie and had been noted to be on the decline, the need to have its sustainable harvest restored to the potential was mooted on the grounds that it contributes to the food security needs of Malawians. To reach the goals set out in this strategy, specific objectives that targeted institutional building and creating awareness of the appropriate resource management methods were drawn and enacted. It is now essential to investigate the extent to which this initiative has yielded the required results.

5.5 The Presidential Initiative on Aquaculture Development

The Presidential Initiative on Aquaculture Development in Malawi (PIAD) came into effect in 2006 and was designed to plug the gaps left by earlier efforts in this sub-sector. This well-pronounced initiative reflects the drive to promote national aquaculture fish production at the levels of commercial and small scale farmers. The idea was mooted upon recognition of the decline in the per capita fish consumption from about 14kg in the 1970s to less than 5.6 kg by 2007 (GoM, 2006; GoM, 2008). It was also envisaged that apart from contributing to the fish consumption, households would benefit from the economic value of marketing the fish and fish products whose prices have been consistently on the rise. More importantly, the outcomes of this initiative would take a lot of pressure off the stocks in the natural water bodies by instituting alternative business avenues. Although the data for farmers, numbers of ponds and the estimated surface area covered by these artificial water bodies is well known, there is need to study in detail the socio-economic dynamics, and the economic and environmental outcomes of these farming practices. For example, there is no explicit data showing the costs and benefits of the farmers' engagement in these endeavours, further investigation into how much socio-economic data is available is warranted and a creation of series that would be useful in the future would also be a good idea.

Important partnerships with a lot of potential were reported such as PIAD, involving JICA, FAO, WorldFish Centre and USAID. It also involved private players such as MALDECO Fisheries, G.K. Aquafarms and Michesi Cage Culture Community. The initiative, which is running from 2006 through 2011, is centered on improving rural livelihoods by building capacities for various stakeholders. While substantial progress has been made, the outcomes of the effort show that delays in disbursement of funds from the government and unfulfilled commitments from donors have derailed implementation and achievement of the goals. This suggests that there is need for a closely observed and more inclusive networking mechanism for all players.

5.6 The Lake Malawi Artisanal Fisheries Development Project

One of the specific efforts by sectoral partners is the Lake Malawi Artisanal Fisheries Development Project which started in 2003 and was planned to run up to 2008/09. The project is undertaken in the districts of Mangochi, Salima, Nkhotakota, Nkhata Bay and Likoma with support from the African Development Bank. The two main goals of this project are:

- To contribute to GoM's poverty reduction efforts by developing sustainable utilization of renewable natural resources; and
- To improve household income by enhancing the management and utilization of fisheries resources in five Lake Malawi littoral districts

The project was conceptualized against the background of artisanal fishers' overdependence on the exploitation of shallow water stocks which reveals the lack of capacity to get into the deeper waters as well as the broader concept of poverty which drives them to use resources unsustainably, thereby exacerbating their poverty cycle. To deal with these issues, explicit project components were put in place, first for providing credit and enhancing savings amongst the communities especially by improving the involvement of women who have a central role in the processing and marketing of fish products. Second, the project focused on capacity building and institutional support to the Malawi Government and staff as well as the community structures. Third is the promotion of fish production, productivity and marketing development, for example by providing Fishing Economic Units (FEUs) to groups of fishers, procuring some essential equipment as well as constructing some necessary infrastructure such as landing sites. As a measure of sustainability the project saw to it that environmentally sustainable techniques, such as watershed management were implemented and adopted on the one hand. On the other hand socio-economic sustainability was ensured by setting up a credit-revolving fund and community empowerment through trainings and participatory fisheries management.

The project has been bedeviled by institutional problems. For instance disbursement of 13 FEUs was way below expectations, contributing to a production of just above 500 metric tonnes of fish way below the expected 11,000 metric tonnes. The general project disbursement rate of the project was also poor, leading to a poor physical implementation record of just about 49% at mid-year of 2008/09 when the project must be winding down. The contribution of this effort, it can be concluded, falls short of what was envisaged at the beginning of 2003. More generally, this outcome shows how difficult it is to put together a winning combination in tackling problems of a complex sector such as fisheries. It would be useful to gather more information on specific projects or partnership efforts involving NGOs and other stakeholders to reveal a more comprehensive picture of the sector.

5.7 The Sustainable Fisheries for Food Security Project

The Government of Malawi (through the Fisheries College), in partnership with Fisheries and Marine Institute of the Memorial University of Newfoundland, have engaged in a Sustainable Fisheries for Food Security project with funding from GOM and Government of Canada (CIDA). The target is environmental sustainability, the minimization of post harvest losses and sustainable fishing practices. This is mainly a capacity building effort involving training of staff and communities through awareness and sensitization. Though still in its early stages, the project reports show that most of its initial targets in training and training arrangements are being met. On the policy front, however, there is need to effect some changes to the advisory board of the training institute, needs assessment and curriculum for the target groups yet to be completed.

5.8 The Small-Scale Offshore Fisheries Technology Development Project

This a project funded by Icelandic Development Programme with an objective of assisting small scale fishers develop fisheries technologies that will help improve their catch from the deeper waters. The project is currently on-going in Mangochi District. The project conducts trainings and sensitisation meetings on the importance of managing fisheries.

5.9 The Innovative Fish Farmers Network Trust (IFFNT)

This constitutes the first officially registered fish producers' association in Malawi. As an initiative supported by JICA, its major objective was to bring together all the fish farmers in Malawi through an association, in order to improve information sharing, financial support and development of aquaculture production. The Department of Fisheries works with the trust in strengthening its potential functions. The department needs to assist the IFFNT (through the provision of grants and technical assistance) to move toward financial independence and to improve and expand their information-sharing capabilities at district and national level. The department also needs to support unregistered community-level fish farmer organisations, such as farmers club. This would include registration of these organisations, undertaking research to identify key constraints and opportunities associated with their activities, and management and technical assistance.

5.10 Other Initiatives

The other initiatives that have been done in fisheries include:

a. Project on Aquaculture Research and Technical Development of Malawian Indigenous Species (JICA)
b. Central and Northern Region Fish Farming Project
c. National Aquatic Resource Management Programme

Water Hyacinth Prevention Project

Annex 6: Description of Malawi's Agro-ecological Zones

Agro-ecological zone	*Description*	*Current SLM Practices*	*Technologies with potential*
1. Mulanje Mountain, Nyika and Dedza	These are hilly tops with rocky outcrops. The soils are shallow. As a result, there is natural vegetation loss, there is slow re-afforestation and also loss of biodiversity.	Forest reserve with managed access, systematic replanting of felled trees, prevention of bush fires	Greater community participation in forest management
2. Lilongwe East and Misuku Hills	These are steep dissected escarpments with deep soils. There is moderate to high erosion with river bank cultivation	Soil and water conservation, agro-forestry and soil fertility improvement, village forest management	Homestead tree planting, live fencing, vetiver hedge rows, minimum tillage, water harvesting, compost manure
3. Nkhata Bay and Mzuzu	Dissected uplands with deep soils. There is gullying with high erosion. There is shifting cultivation	Soil and water conservation, agroforestry and soil fertility improvement	Alley cropping, village forest management, intercropping, incorporating crop residues
4. Lilongwe Plain	Flat plains with deep soils. There is declining soil fertility	Soil and water conservation, agroforestry and soil fertility improvement	Homestead tree planting, live fencing, vetiver hedge rows, minimum tillage, water harvesting, compost manure and organic fertilizers
5. Namwera	Gently sloping foot slopes with very deep soils. There is gullying and soil erosion	Soil and water conservation, agroforestry and soil fertility improvement	Homestead tree planting, vetiver hedge rows, water harvesting, and compost manure
6. Zomba and Blantyre Highland Belt	Dissected uplands with moderate slopes and with deep soils	Soil and water conservation, agroforestry and soil fertility improvement	Alley cropping, homestead tree planting, intercropping, incorporating crop residues, inorganic fertilizers
7. Nkhamenya, Kasungu and Mchinji Plain	Flat plains with very deep soils. Soil fertility is declining and soils have low organic matter	Soil and water conservation, agroforestry and soil fertility improvement	Homestead tree planting, live fencing, vetiver hedge rows, minimum tillage, water harvesting, compost manure and inorganic fertilizers
8. Chilwa Plain,	Gently sloping with very	Soil and water	Homestead tree planting,

Agro-ecological zone	*Description*	*Current SLM Practices*	*Technologies with potential*
Mchinji, Kasungu	deep soils. There is river bank and valley cultivation	conservation, agroforestry and soil fertility improvement	live fencing, vetiver hedge rows, minimum tillage, water harvesting, compost manure and inorganic fertilizers
9. Lake Chilwa surroundings	Flat Lake margin with very deep soils. There is river bank cultivation and there is also sedimentation		Vetiver hedge rows, river bank protection, land use planning
10. Phalombe Plain	Flat lands with very deep soils	Soil and water conservation, irrigation	Vetiver hedge rows, river bank protection, catchment management and land use planning
11. Upper Shire valley	Flat to almost flat alluvial plains with mopanic soils. There is gullying.	Soil and water conservation, agroforestry and soil fertility improvement	Land use planning
12. Mulanje, Karonga North	Hillsides with moderate slopes. There is soil erosion in the areas	Soil and water conservation, agroforestry and soil fertility improvement	Soil and water conservation, agroforestry, watershed management
13. Chikangawa, Wenya	Moderately steep dissected plateaus.	Protected forest with managed access re-afforestation, systematic replanting of felled trees, prevention of bush fires	Soil and water conservation, alley cropping, homestead tree planting, incorporating crop residues, land use planning, watershed management, greater community participation in forest management
14. Dowa Hills, Marange Range	Hillsides, moderate slopes, moderately deep soils	Community based forest management, soil and water conservation	Alley cropping, homesteads tree planting, intercropping, watershed management, greater community participation in forest management

Source: Mlava, personal communication

Annex 7: Malawi's Protected Wildlife Resources

The Department of National Parks and Wildlife is an executive government arm mandated through legal instruments, (the National Parks and Wildlife Act 1992 revised in 2004, and the Wildlife Policy of 2000) to protect Malawi's wildlife resources and regulate their sustainable use for the benefit of Malawians. The Department's core functions include the implementation and enforcement of the Act's legal and regulatory provisions protected area management and enforcement, wildlife community extension and conservation education, wildlife research and planning, and organisational administration.

Malawi's protected areas comprise five national parks, four wildlife reserves, and three key nature sanctuaries. The national parks are Nyika, Kasungu, Lengwe, Liwonde and Lake Malawi. The four wildlife reserves are Majete, Mwabvi, Vwaza Marsh and Nkhotakota, while the three key wildlife nature sanctuaries are Mzuzu, Lilongwe and Michiru. In addition, wildlife also exists on customary land where they are treated as common goods contributing to food security and household income. Key features of the national parks, wildlife resources and one of the nature sanctuaries described hereunder[91].

7.1 Nyika National Park

Located in the northern region districts of Rumphi and Chitipa and bordering Zambia to the west, Nyika National Park has a land area of 3,124 square kilometres. It offers mountain biking, trekking, horse riding safaris and conventional 4 by 4 excursions. The most common game include reedbuck, roan antelope, duiker, eland, warthog, bush pig, leopard and zebra. The lowlands keep elephants and buffalo. It also has over 400 species of birds with red-winged francolin being endemic to Nyika.

In 1996, The Nyika-Vwaza Conservation Project funded by the German Cooperation (GTZ) began and lasted until 2002. The project was aimed at strengthening law enforcement system, improve infrastructure and develop human capacity in Nyika National Park and Vwaza Wildlife Reserve. Tree cutting represents the most common illegal activity accounting for over 54% of illegal activities between 1989 to 1998. Three species: reedbuck, eland antelope and bushbuck accounted for 65% of total species poached between 1996 to 2005. Population estimates are shown in Table A4 below.

Table A4: Animal Population Estimates for Nyika National Park

Species	***1992 Estimated Population***	***2002 Estimated Population***
Eland	1,203	523
Roan antelope	571	430
Reedbuck	2,184	658
Zebra	470	200

Source: Department of National Parks and Wildlife of Malawi.

The figures in the table above show that poaching has been rampant in the park over the years as the estimated population of all four reported species declined over the ten year period..

[91] The summaries on parks and wildlife resources are based on information from interviews with DNPW and various websites including http://www.africaguide.com/country/malawi/parks.htm.

7.2 Kasungu National Park

Located in Kasungu district and bordering Zambia to the west, the park has 2,316 square kilometres of natural woodland and bush with occasional stretches of more open grass. In recent years, poaching has reduced the number of some animal species. Elephants, antelopes, buffalo and zebra can be seen in the park. Predators such as leopards, hyenas, servals and jackals are present in the park.

Tree cutting is the most common illegal activity in the national park. Poaching is represented by gunshots, drying racks, hunting dogs, encounters with armed groups. Use of fire arms is widespread in the park. Poaching from Zambia is also common. Elephants were the most targeted species for poaching representing 38% of species mortality reported from 1993 to 2003 followed by buffalo (23%). The species population estimates are shown in Table A5 below. Generally it is felt that animal poaching has depleted most animal populations in this reserve.

Table A5: Animal Population Estimates for Kasungu National Park

Species	***Observed***	***Population estimates***
Bushpig	7	78
Bushbuck	22	245
Caracal	1	11
Duicker	27	300
Eland	3	33
Elephant	16	178
Impala	21	234
Kudu	24	267
Leopard	2	22
Hartebeest	6	67
Oribi	2	22
Puku	31	345
Reedbuck	28	311
Roan	1	11
Warthog	13	145
Zebra	8	89

Source: Wildlife and Environment Society of Malawi, Lilongwe Branch.

7.3 Lengwe National Park

Lengwe National Park is 887km^2 in size and lies entirely in Chikwawa District in the Lower Shire Valley (Southern Malawi) at an altitude of between 30 and 100m above sea level. The Park consists of two ecological units; the eastern salient also known as the Old Lengwe and the western upland known as Lengwe Extension Area

Lengwe was originally established to conserve the most northernmost population of nyala antelope (*Tragelaphus angasi*) in a discontinuous range which extends from Natal in South Africa through eastern Zimbabwe and central Mozambique to the southern end of Malawi. Nyala numbers built up from an estimated 350 in 1968 (Bell & Dudley 1982) to 3,318 in 1980 (Bell 1981) and their numbers were in excess of 4,000 animals in 1982 (Bell & Banda 1983), despite a significant culling programme which was initiated in 1981. Mphande & Jamusana (1983) reported that 419 nyala were culled in 1981, followed by 840 nyala in 1983.

Other important animals include; buffaloes, impala, kudu, warthog, bushbuck, common duiker, bush pig, livingstoni suni, grysbok, hyena, leopard, vervet monkey, elephant shrews, mongoose, reedbuck, civet, serval cat, and bush baby.

Tree cutting (for timber, firewood, construction and other uses) followed by cultivation were the major illegal activities carried out in Lengwe National Park accounting for 75% of the illegal activities reported (Alvarez, 2006). These were mainly the case because of increase in human population around the park. Animal poaching was reported to be less than six percent. The World Bank implemented a four year Collaborative Management project aimed at promoting sustainable wildlife collaborative management among the community to improve law enforcement, promote research to reduce poaching. Between 1993 to 2003, an average of 900 wire snares were removed per year. It was reported that number of wire snares increased with poverty and hunger among the surrounding population. Nyala and impala are the most targeted species in Lengwe. The estimated species population is shown in Table A6.

Table A6: Animal population estimates for Lengwe National park

Specie	1998	2000	2001	2002	2003	2004	2005	2006	2007
Nyala	2527	1363	1404	1040	1084	964	889	806	781
Impala	4250	3387	3455	3480	2980	2493	2054	2108	2329
Buffalo	4144		2921	1548	1161	916	1069	627	666
Kudu	302	463	476	229	226	212	527	389	371
Warthog	390	986	967	742	846	859	987	741	499
Bushbuck	-	-	-	26	197	214	149	313	105
C.Duicker	-	-	-	12	29	47	80	108	82
Bushpig	-	-	-	24	39	27	68	102	-
Suni	-	156	207	21	31	29	112	216	-
Reedbuck	-	-	-	11	17	13	-	21	-
Grysbok	-	-	-	-	-	-	-	95	43
Totals	**11613**	**6355**	**9430**	**7133**	**6610**	**5774**	**5935**	**5526**	**4876**

Source: Department of National Parks and Wildlife of Malawi. .

The population of the park's flagship species of nyala, buffalo and impala have declined including other animal species.

7.4 Liwonde National Park

Lies about 160 km north of Blantyre City in Machinga district and covers 538 square kilometres. It has a relatively higher number of elephants[92], hippo, crocodile, antelope, kudu, sable, waterbuck, bushbuck, leopards and black rhino. There is also significant bird population which include fish eagle, pel's fishing owl and weaver birds. There is an airstrip near the lodge served by scheduled and charter flights.

Four types of poaching have been reported in the National Park namely illegal hunting, illegal fishing, firewood cultivation and tree cutting. During the 1996-2004 period, there was an intervention by the Frankfort Zoological Society which among other things provided anti-poaching training, field support equipment and leadership. Furthermore, some villagers were paid by the project to provide information about poachers, game meat trade and firearm possession. This initiative resulted in

[92] The number of elephants at the park was estimated to be 400 in 2003.

arrests inside and outside the park. Data from 1995 to 2006 indicated that the waterbuck was the most targeted animal followed by impala and elephant. In 2005, 28 waterbucks were killed and three elephants and one hippo. Other animals killed totalled 33.

Data on population estimates indicate that on average the number of animals in the park have been on the increase as Table A7 below shows.

Table A7: Animal Population Estimates for Liwonde National Park

Species	***1991 Population***	***2008Population***	***Status***
Elephant	423	652	+
Buffalo	-	781	
Eland	-	62	
Sable antelope	-	527	
Waterbuck	854	2566	+
Impala	451	2652	+
Roan antelope	=	43	
Hartebeest		70	
Reedbuck		89	
Bushbuck	32	449	+
Warthog	163	1547	+
Bush pig			
Common duiker		146	
Kudu	90	187	+
Grysbok			
Black Rhino		10	
Zebra		74	

Source: Department of National Parks and Wildlife of Malawi. Note: Blanks indicate that no data were available.

7.5 The Lake Malawi National Park

This is the first freshwater national park and is a UNESCO World Heritage site. There is a veritable aquarium of tropical fish. The mbuna (chiclids) are more abundant and varied here than anywhere in the world. Away from the lake are baboons, antelope and hyrax. No data are available for the estimated population of species.

7.6 Majete Wildlife Reserve

Majete Wildlife Reserve (689km^2) is located in the middle of Shire Valley in Chikwawa district about 70km southwest of Blantyre. The Reserve was established under the Game Act (Cap. 66:03) and gazetted in its present form by the Proclamation of Alteration of Boundaries (Majete Wildlife Reserve), 29th September 1976, published as Government Notice No.146 of 1975.

Majete Wildlife Reserve and the surrounding area lost its entire elephant population over the period 1986 to 1992. The large part of the killing was done by Mozambican refugees, and also local participation in the process. Illegal hunting of other wildlife species also accelerated at that time. An aerial survey carried out by Gibson (1997) using block counts at an overall sampling intensity of about 25% showed absence of large mammals save for sable as the only antelope reported in significant numbers (estimate 113, with 95% confidence range of 28-301).

By early 2003, Majete Wildlife Reserve had been depleted of most of its wildlife due to poaching and prospects of it recovering seemed remote. It was generally characterised by rampant poaching for animals, logging and charcoal burning. The Government of Malawi entered into a management concession agreement with African Parks Limited to manage the reserve for 25years under the public/ private partnership model. The concession encompasses the rehabilitation of the biodiversity, infrastructure and pursuing community work in and around the reserve.

The elephant is one of the key species in the reserve that was reintroduced in addition to other species after it got extirpated due to poaching. Other species includes; buffaloes, sable antelopes, waterbucks, black rhino, reedbucks, zebra, eland, hartebeest, warthog, impala, nyala, greater kudu, hippo, crocodiles, common duiker, bushbuck and suni.

Table A8 below shows the estimated species population prior to 2003, species introduced in 2003 to 2009.

Table A8: Animal Population Estimates for Majete Wildlife Reserve

Species	***Before restocking***	***After restocking programme***			
	Population 2003	***Population 2005***	***Population 2006***	***Population 2007***	***Population 2009***
Elephant	0	-	73	72	215
Buffalo	0	240	328	365	325
Sable	0	125	154	228	299
Waterbuck	25	106	156	232	295
Impala	0	251	289	277	428
Zebra	0	47	110	69	177
Nyala	0	27	36	43	58
Eland	0	29	46	53	78
Warthog	20	91	104	116	158
Hartebeest	0	-	15	31	28
Black Rhino	0	2	2		7
Kudu	25	125	131	145	0
Bushbuck	Present	73	94	78	0
Common Duiker	Present	116	148	136	0
Reedbuck	Present	87	97	91	0
Grysbok	Present	116	114	113	0
Total	70	1435	1897	2049	2068

Source: African Parks and Department of National Parks and Wildlife of Malawi.

7.7 Mwabvi Wildlife Reserve

This reserve is located at the southernmost tip of Malawi in Nsanje district. With 135km^2 it is the smallest of all the Malawian reserves. Wildlife has declined in the area although some animals such as buffalo, nyala, kudu and sable antelope can still be seen. The DNPW entered into an ecotourism concession agreement with Project African Wilderness to protect and restore the Mwabvi Wildlife Reserve. It aims to work with local people and the government to integrate social, economic and environmental solutions to create a sustainable future for the reserve.

The most common illegal activity in Mwabvi is tree cutting and timber representing about 80 % (Alvarez, 2006). The reserve still has natural woods which are on demand by the wood carving industry. Number of animals killed ranged from two to thirteen. Kudu and warthog were the main species with twenty kudu and fourteen warthogs killed between 1986 and 1997.

On animal population estimates, some species indicate an increasing trend as shown in Table A9.

Table A9: Animal Population Estimates for Mwabvi Wildlife Reserve

Species	***1997 estimated population***	***2008 estimated population***	***Status***
Common duiker	25	115	+
Kudu	20	192	+
Warthog	28	73	+
Bushpig	45		
Nyala		63	
Impala		195	
Buffalo		252	
Bushbuck		11	
Sable		40	

Source: Department of National Parks and Wildlife of Malawi. Note: Blanks indicate that no data were available

7.8 Vwaza Marsh Wildlife Reserve

Vwaza Marsh Wildlife Reserve covers an area of 986km² and the western of it's northern boundary coincides with the Malawi- Zambia border. The reserve has three major landscape types, the plateau found on the western sector, the hills and pediment occupies the eastern half of the area and the wetland alluvial type found on the central and southern boundary of the reserve. The altitude varies from 1082m to 1160 m above sea level. With about 300 bird species recorded, some of the birds one can see include stork, heron and the white faced tree duck. Animals available include elephant, buffaloe, hippo, kudu, hartebeest, warthog, puku, zebra, impala, duicker, bushpig and grysbok.

Tree cutting is the most common illegal activity in the reserve accounting for 39% of all illegal activities recorded. Elephants are the most common species targeted representing 20% of all poached animals. Between 1983-1985 alone, 49 elephants were killed. There is also trans-boundary poaching from the Zambian side of the border as animals trek to Zambia in search of water during the dry season. Table A10 below shows the estimated population of the elephants.

Table A10: Animal Population Estimates for Vwaza Marsh Wildlife Reserve

Species	***1996 Population estimate***	***2000 Population estimate***	***2002 Population estimate***
Elephant	582		342
Buffalo	176	140	
Sable	11		
Impala	133	190	
Hippopotamus	133	180	
Roan antelope	93		140
Hartebeest	174		201
Reedbuck	54		152
Bushbuck	176		140
Warthog	11		201
Bush pig	4	39	
Common duicker	55	140	
Puku		48	
Kudu		222	
Grysbok		55	
Zebra		16	

Source: Department of National Parks and Wildlife of Malawi. Note: Blanks indicate that no data were available.

Some of the species such as puku and zebra were characterised to have reached alarmingly low levels and were in danger of becoming locally extinct unless some action was taken.

7.9 Nkhotakota Wildlife Reserve

The reserve covers an area of 1,800 square kilometres and borders the lakeshore area and the Kasungu/Lilongwe plains of the central region. The major disadvantage it has is that it is difficult to access. There is a good range of mammal although the environment makes it difficult to see.

Tree cutting represented the most common illegal activity in the park representing 40%. In August-September 1994 scouts went on strike demanding field allowances and this resulted in increased poaching. The reserve had seven scouts in 2006, obviously not adequate and some camps had been abandoned. Elephants were the most targeted species accounting for 31% of all species killed. Although no estimates were available, a decline in animal population has been evident over the years. Some species such as sable antelope, buffalo and zebra are rarely seen.

7.10 Michiru Nature Sanctuary

Michiru Nature Sanctuary covers 16 km^2 and is located between Blantyre City and Chileka about 7.5 km Blantyre West and 6 km South west Chileka Airport. Altitude at mountain summit (visitors interest point) is 1470 meters. The sanctuary can be accessed through Chilomoni – Chileka by-pass earth road, and Chileka Airport road. Some of the interesting features include Michiru Peak (altitude 1470m) offers nice scenic views of Thyolo tea estates, Shire river, Chileka airport, Blantyre city and Mulanje on a clear day; hyena hide caves and six nature walking trails which offers bird watching, game viewing and tree identification.

The animals species available include bushbuck, common duiker, klipspringer, grysbok, bushpig, rock dassie, side striped jackal, leopard and hyena among others. The sanctuary has a record of over 200 bird species. No animal research surveys have been undertaken to estimate the populations of the animal species. However, patrol sightings and visitor observations indicate the status of the animals to be stable. The major illegal activity is poaching for firewood and greenwood.

Annex 8: Wildlife Benefits, Stocks and Visitor Trends

Table A11: Wildlife resources harvested in all protected areas - 2004-2009

Protected Areas	***Honey (kg)***	***Bee wax (kg)***	***Fish (kg)***	***Medicinal Plants(kg)***	***Reeds (bundle)***	***Bamboo (bundle)***	***Palm Fronds (bundle)***	***Thatch Grass (bundle)***	***Mushroom (kg)***	***Termites***
Nyika National Park	54,452.3	15,146.2	3,339.05	358	2,279	8,669	2,757	7,612	11,051	8,794.5
Vwaza Marsh Wildlife Reserve	53	0	27,751.5	124	1,324	0	1,337	14,665	1,284.8	20
Mzuzu Nature Sanctaury	118	0	0	0	0	0	0	0	20	3
Kasungu National Park	660	60	0	0	158	184	0	3,971	132	0
Nkhotakota Wildlife Reserve	110	0	99.5	0	0	0	0	31,477	2,993	650
Lilongwe Nature Sanctuary	0	0	0	O	0	0	0	0	0	0
Lake Malawi National Park	0	0	0	0	0	0	0	0	0	0
Liwonde National Park	0	0	0	0	0	0	0	0	0	0
Michiru Nature Sanctuary	230	0	0	2,54.3	0	528	0	43,686	0	0
Majete Wildlife Reserve	0	0	0	0	0	0	0	29,291	0	0
Lengwe National Park	61	0	0	0	0	0	0	90,151	0	0
Mwabvi Wildlife Reserve	0	0	0	0	0	0	0	1,452	0	0
Totals of resources harvested	55,684.3	15,206.2	31,190.05	736.3	3,761	9,381	4,094	222,305	15,480.8	9,467.5
Economic values										
Unit Price (Malawi Kwacha)	350	300	300	150	250	400	300	50	200	150
Total (MK)	19,489,505	4,561,860	9,357,015	110,445	940,250	3,752,400	1,228,200	11,115,250	3,096,160	1,420,125
Grand Total (MK)	**55,071,210.00**									

Table A12: Trend of animal populations in Lengwe National Park

Specie	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***Percent change (1998 -2007)***
Nyala	2527	1084	1363	1404	1040	1084	964	889	806	781	-69.0
Impala	4250	2823	3387	3455	3480	2980	2493	2054	2108	2329	-45.0
Buffalo	4144	2485		2921	1548	1161	916	1069	627	666	-84.0
Kudu	302	461	463	476	229	226	212	527	389	371	+23.0
Warthog	390	901	986	967	742	846	859	987	741	499	+28.0
Bushbuck	-	-	-	-	26	197	214	149	313	105	
C.Duicker	-	-	-	-	12	29	47	80	108	82	
Bushpig	-	-	-	-	24	39	27	68	102	-	
Suni	-	-	156	207	21	31	29	112	216	-	
Reedbuck	-	-	-	-	11	17	13	-	21	-	
Grysbok	-	-	-	-	-	-	-	-	95	43	
Totals	**11613**	**7754**	**6355**	**9430**	**7133**	**6610**	**5774**	**5935**	**5526**	**4876**	**-58.0**

Table A13: Estimated Animal Population trend in Majete Wildlife Reserve

Species	***Population estimate 2003 (before restocking)***	***Population estimate 2005 (after restocking)***	***Population estimate 2006***	***Population estimate 2007***	***Reintroduced 2003-2009***	***Percent Population change (2003-2009)***
Elephant	0	-	73	72	215	+ 100
Buffalo	0	240	328	365	325	+100
Sable	0	125	154	228	299	+100
Waterbuck	25	106	156	232	295	+92
Impala	0	251	289	277	428	+100
Zebra	0	47	110	69	177	+100
Nyala	0	27	36	43	58	+100
Eland	0	29	46	53	78	+100
Warthog	20	91	104	116	158	+87
Hartebeest	0	-	15	31	28	+100
Black Rhino	0	2	2		7	+100
Kudu	25	125	131	145	0	
Bushbuck	Present	73	94	78	0	
Common Duiker	Present	116	148	136	0	
Reedbuck	Present	87	97	91	0	
Grysbok	Present	116	114	113	0	
Total	70	1435	1897	2049	2068	+97

Table A14: Visitor trend and revenue for Lengwe National Park

Parameter	***2006/2007***	***2007/2008***	***2008/2009***
Number paying visitors	734	1214	1247
Number non-paying visitors	655	1749	1350
Park entry revenue (MK)	639,300	460,180	508,760

Table A15: Visitor trend and park income for Majete Wildlife Reserve

Year	***Total Park Visitors***	***Total Income (MK)***
2006	315	238, 000
2007	1,699	3, 340,400
2008	2,059	6,031,900
2009	4,053	14,234,920

Annex 9: Costs of off-site soil erosion on hydro-electric generation

Weed barrage at Liwonde	**MK Cost**
Capital costs	
Shore Conveyer and its Trailer	
Aquatic Vegetation Cutter	
Aquatic Vegetation Harvester	
Proposed additional Harvester for Liwonde Barrage (MCC proposal)	
Work-boat and its Trailer	
Oil spill Boom	
3xTipper Trucks	
Total capital cost	**135,715,328**
Operational costs (July07-June08 FY)	
Labour (permanent staff)	17,630,000
Sundry, services & supply	4,230,000
Maintenance	3,400,000
Hiring of Tippers	16,000,000
Fuel	8,226,000
Total annual operating cost	**49,486,000**

Sources: ESCOM and MCC

NKULA POWER STATION	
Capital costs	
Cost of dredger and workboat	25,000,000
Operating costs	
Dredging operation cost (Jul 08 – Dec 08)	7,500,000
Diving services costs	4,000,000
TEDZANI POWER STATION	
Capital costs (from MCC proposal)	
Dredger	350,364,964
Estimated operating costs (as for Nkula)	11,500,000
Kapichira Power Station	
Capital costs (from MCC proposal)	
Dredger	525,547,445
Estimated operating costs (as for Nkula)	11,500,000
Other capital costs (from MCC proposal)	
Trash diversion for Nkula, Tedzani and Kapichira Head ponds	116,788,321
Lost generation revenue from outages related to trash repair	
Lost MWh for repairs (3 stations, Jan - March 09)	38423.16
Cost of unserved energy (from MCC, 2009) MK/kWh	32.12
COUE MK	1,234,028,496

Annex 10: Summary of Case Studies

10.1 Introduction and Scope

The case studies summarized in this annex were conducted as a basis for establishing the link between natural resource management and macroeconomic performance. Focus was on the impacts of soil degradation, deforestation, wildlife, as well as fishing and aquaculture on national development, food security and poverty. The specific tasks to be accomplished were as follows:

a) Selection of case studies in consultation with GoM;
b) Acquisition of appropriate remotely sensed materials;
c) Conducting image analysis for land cover, soil degradation and siltation using an appropriate GIS package;
d) Visits to the selected catchments (i.e. Linthipe, Middle and Lower Shire) and consultation with relevant stakeholders;
e) Conducting impact analysis and assessments in agriculture, fisheries, wildlife and forestry; and
f) And conducting cost-benefit analysis for environmentally sustainable interventions

10.2 Approach

In order to accomplish these tasks, and building on the preliminary analysis conducted in prior tasks, the methodologies included calculation of agricultural land and water resources degradation rates and trends, calculation of forest depletion rates and trends; and preliminary calculation of fish depletion rates and trends. The visits to the sites validated existing data and generated new data where necessary.

In consultation with Technical Committee of the Malawi Poverty and Environment Initiative, three catchments were selected as case studies, namely Linthipe River Catchment, Middle Shire and Lower Shire Catchments. An image analysis of Satellite Images for 1997 and 2008 was conducted using Erdas Imagine to determine vegetation indices and soil degradation. The three catchments were also visited in May to July to consult relevant stakeholders (water boards, ESCOM, irrigation schemes, park and Wildlife reserve management, government staff, fishermen and farmers). Relevant literature on the catchments was also consulted. These formed the basis of an impact analysis and assessments in agriculture, fisheries, wildlife and deforestation.

A summary of the results from the impact analyses follow. The full case studies are available as separate reports.

10.3 Summary of Results from Impact Analysis: Lower Shire Catchment

10.3.1 Wildlife resources

The high concentration of biodiversity in Malawi occurs in protected areas. Outside these areas, there is a general degradation of wildlife resources largely due to increasing human population pressure, poverty and inadequate appreciation of the resources benefits which often lead to habitat loss and overexploitation. An analysis of the state-managed Lengwe National Park and the privately-managed Majete Wildlife Reserve, both of which are in the Lower Shire, reveals that biodiversity has been negatively affected by human activities through poaching, encroachment and other illegal uses.

Together the parks have species which include elephants, buffaloes, sable antelopes, waterbucks, black rhino, reedbucks, zebra, eland, hartebeest, warthog, impala, nyala, greater kudu, hippo, crocodiles, common duiker, bushbuck, suni, buffaloes, impala, kudu, warthog, bushbuck, common duiker, bush pig, , grysbok, hyena, leopard, vervet monkey, elephant shrews, mongoose, reedbuck, civet, serval cat, bush baby and over 300 species of birds.

Based on the current market values of wild animals and the 2007 animal populations, the total economic value of animals in Lengwe National Park is estimated at US$17,727,500 (MK2, 481, 850,000). However, from the selected Nyala and Impala antelopes that were poached from the period from 1998 to 2005 an estimated economic loss of US$1,290,000 (MK180, 600,000) was registered. The Majete has shown that with re-introduction and restocking of animal species, improved park infrastructure and law enforcement the maximum economic value of the animals in the park is higher at approximately MK11, 200, 000,000 (US$80,000,000).

Through co-management as instituted in Lengwe National Park, wildlife resources would contribute to improved livelihoods, food security and poverty reduction of the local communities living adjacent to protected areas.

10.3.2 Forestry resources

The cultivated land in Lower Shire Catchment had increased from 250,987 ha in 1994 to 427,700 ha in 2008 representing an estimate of 21% (176,713 ha) increase in land area under cultivation between the two time periods. This translates to 1.5% (12,622 ha) annual increase in land area under cultivation in the last 14 years.

The forest area had changed from 486,607 ha in 1994 to 298,063 ha of forest land in 2008, providing a decline of 188,544 ha of forest land during the 14 year period. This translated into a decline of 188,544 ha (22.35%) for the entire 14-year period, resulting in 1.59% annual decline of forest land (14,559 ha of forest land being lost yearly). In this context, 1.59% would be regarded as rate of deforestation experienced in the Lower Shire Catchment.

10.3.3 Fisheries resources

Fish provides about 60-70% of the dietary animal protein and about 40% of the total protein intake in rural and urban diets of Nsanje district. The Shire River system contributes about 6% - 21% of the total national fish landings annually. Over the period of ten years recorded fish catches at designated landing sites have declined from 1396.00 metric tonnes in 1999 to 274.62 metric tonnes in 2006. This trend of catches is attributed to an increased number of destructive fishing gears, frequent changes of water level in the water bodies and impact of the water hyacinth. It is also reported that fish stocks in the district continue to decline in production, in addition to scarcity and extinction of other valuable species. The growing number of fishers and their gears, open access to the resource, limited employment and lack of credit opportunities, have led to the overexploitation of the resource. Consequently fishers require higher fishing efforts for very little catches which has resulted in most cases to declining household incomes. In a particular Stratum, the trend of catches has slightly improved from 2006. This has been attributed to formation of and performance of active Beach Village Committees. Through Participatory Fisheries Management(PFM) there has been an improvement in mesh sizes for the gears such as Gillnets, Cast nets and Beach seine nets over the past ten years. Extension services have been intensified to sensitize the fishing communities on the importance of conserving the fisheries resource. Riverine cultivation is being discouraged and noxious weeds are physically removed.

Aquaculture is also being intensified to supplement the Capture fisheries.

10.3.4 Soil Resources

Farmers in the Middle and Lower Shire have encroached into marginal areas. An overlay of slope classes and land cover maps indicate cultivation on marginal lands such as on steep slopes and along rivers, and on soils with a high potential for erosion. Over the 14year period (1994 – 2008) there has been a 21% increase of general cultivation and 0.5% on wetlands cultivation.

Off-site effects of erosion are manifested in the effects of siltation in rivers and irrigation schemes in the catchment which call for dredging and clearing of irrigation channels and reduced water quantity/availability for irrigation. For example, according to ILRADP, Nkhate Irrigation Scheme requires MK 67, 587,300 for river training and protection works and MK 80,702,100 for catchment conservation (Thyolo Escarpment). For Muona Irrigation Scheme MK 32,823,400 is required for river protection works and MK 47,262,900 for Thyolo Escarpment catchment conservation.

The catchment has a good irrigation potential. Irrigation technologies being recommended in the catchment include treadle pump irrigation using shallow wells, canalization technology or direct harnessing of water from streams/rivers, motorized sprinkler and surface irrigation, river diversion-gravity fed, bucket/watering can and river/water impoundments.

Other effect experienced by farmers is the inability to sustain pumping costs which have arisen because of lowered water table. On average the water table has dropped by 2meters below land surface.

Irrigation technologies and equipment are under- utilized due to drying rivers. There are also serious salinity problems in some sites such as Chitsa hindering irrigation development.

According to ADD reports, the technologies that need to be intensified to conserve soil and water are contour ridging particular in upland areas, and vetiver grass hedgerows and gully reclamation. On upland areas vetiver would be established on marker ridges. For flat areas, vetiver hedge rows would be established on pegged contour lines and garden boundaries.

Crop ridges on all cultivated land with slopes greater than 3% but less than 13% should be realigned to the contour. This would control runoff and erosion and increase infiltration, particularly when in combination with tied ridges. Vetiver (or other thick stemmed grasses) should be planted on contour markers and managed to form vetiver hedgerows which provide a barrier to runoff.

There are also technologies that have been termed ‘best bets’ which should be used to enhance or improve soil fertility. These include application of inorganic fertilisers, cattle manure, incorporation of crop residues and compost into the soils. Undersowing with *Tephrosia* is a beneficial practice under smallholder conditions with moderately to severely degraded.

10.4 Summary of Results from Impact Analysis: Middle Shire Catchment

10.4.1 Forestry resources

The Middle Shire Catchment was heavily cultivated with 65.7% (689,300 ha) of the total area of the catchment being under cultivation in 2008. These cultivated lands had increased from 518,850 ha in 1994 with an estimated annual increase of 1.16%, resulting in 12,175 ha of new cultivated land being opened up every year for the past 14 years. Most of these new cultivated lands must have been converted from forest land in the catchment.

The forest area had declined from 515,278 ha in 1994 to 311,449 ha of forest land in 2008, providing a decline of 203,829 ha of forest land during the 14 year period. This translated into a decline of 29.67% for the entire 14-year period, resulting in 2.12% annual decline of forest land (14,559 ha of forest land being lost yearly). In this context, 2.12% would be regarded as rate of deforestation experienced in the catchment.

10.4.2 *Water resources*

The combined effects of high rate of deforestation, soil degradation and forest degradation of the catchment have been visible on water quality and quantity for domestic use and electricity generation. The Shire river is also increasingly being affected by invasive weeds and trash which have in turn affected the four hydroelectric stations located on the river.

Increased turbidity during the rainy season as a result of runoff from the upland that contains suspended solids raises the cost of providing water. Up until the late 1990s, the power stations used to operate without any major environmental problems. Due to degradation of the physical environment in the catchment area of the Shire River, silt and trash loads have been transported into the reservoirs at Nkula , Tedzani and Kapichira Falls. Accumulation of silt lowers down the volume of the dam/reservoir resulting in insufficient water to run the plants at the power stations. In June 2009, 40% and 60% of the reservoirs at Kapichila and Nkula respectively were silted up.

The silt also causes abrasion/eroding effect to the machines (leading to cavitation of turbines). The weeds and trash clog the screens thereby restricting enough water going to the machines.

A total capital cost of MK89,000,000.00 and total annual operation costs of MK33,486,000.00 are required to manage the weeds at the Liwonde Weed Management Station. Further money is required to manage the weeds/trash and silt at the water intake sites of each power station, to periodically repair turbine underwater parts and screens. Over MK153 million revenue was lost due to the problems of trash and weeds at the power stations for the period January to March this year (2009)

10.4.3 Soil resources

An Erosion Hazard assessment of the catchment, shows that erosion is prevalent. SLEMSA, the erosion hazard model considers vegetation cover, climate, soils, and topographic characteristics.

Interventions

Iinappropriate land use and management practices in catchment areas, weak enforcement of NRM legislation, conflicting NRM policies, lack of alternative and affordable sources of energy, population pressure and lack of coherence in the institutional arrangements to effectively coordinate and implement NRM programs promote deforestation, soil erosion and sedimentation resulting in unreliable and poor power generation[93]. A comprehensive study and analysis of biophysical baseline data, social economic and human influences in the catchment is proposed. This will allow for an integrated and more holistic approach to the NRM problems leading to the development and implementation of site specific interventions in priority catchments. The Water Resources Investment Project proposes an assessment of Catchment Degradation to establish the status of upper catchments including identification of location, types and intensity of the most damaging activities and also mapping and quantifying sediment load in main river basins.[94]

A number of technologies aimed at addressing issues of land degradation have been developed and promoted among smallholder farmers over the years. The focus has mostly been in soil fertility improvement, soil and water conservation, agroforestry and forestry. In the catchment interventions should integrate management of locally available soil, water, and biological resources. Such technologies include conservation farming, various cultivation techniques and water collection and runoff control measures.

Crop ridges on all cultivated land with slopes greater than 3% but less than 13% should be realigned to the contour. This would control runoff and erosion and increase infiltration, particularly when in combination with tied ridges. Vetiver (or other thick stemmed grasses) should be planted on contour markers and managed to form vetiver hedgerows which provide a barrier to runoff.

There are also technologies that have been termed 'best bets' which should be used to enhance or improve soil fertility. These include application of inorganic fertilisers, cattle manure, incorporation of crop residues and compost into the soils. Undersowing with *Tephrosia* is a beneficial practice under smallholder conditions with moderately to severely degraded soils

10.5 Summary of Results from Impact Analysis: Linthipe Catchment

10.5.1 Forestry resources

In 1994 a large proportion (57.37%) of the catchment was under cultivation (487,677 ha). These cultivated lands had increased to 502,049 ha (59% of the total catchment area) in 2008 with an estimated increase of area under cultivation of 1.7% (14,372 ha), resulting in an annual rate of increase of 1,027 ha (0.12%).

The forest area had changed from 315,693 ha in 1994 to 236,543 ha in 2008, providing a decline of 79,150 ha during the 14 year period. This translated to a decline of 9.32% of the forestland for the entire 14-year period. The catchment therefore lost on yearly basis an average of 5,653 ha (0.67%) of forestland to other land uses during the 14-year period. In this context, 0.67% would be regarded as rate of deforestation experienced in the catchment.

The analysis and the field verification exercise demonstrated that much of the forest degradation in the catchment occurred in Lilongwe, Salima and Dowa areas (around Dzalanyama and Thuma forest reserves) where much of the charcoal and fuel wood are produced and supplied to Lilongwe City.

[93] Millennium Challenge Account. Draft TORs for the Consultancy to Prepare an Environmental and Natural Resources Management Action Plan for areas impacted by the Millennium Challenge Cooperation (MCC) supported programme in Malawi. 2009

[94] Ministry of Irrigation and Water Development. TORs for Consultancy Services for Water Resources Investment Strategy. Second National Water Development Project (NWDP II). Sept. 2008, 52-68

These areas are regarded as catchment areas for fuel wood and charcoal supply to Lilongwe City (BEST Malawi, 2008).

Malawi BEST (2008) reported that an overall sustainable supply of wood biomass to Lilongwe City has moved from a position of slight excess at the time of the last national biomass study (1996) to one where demand is greater than sustainable supply by 31%, based on the "minimum" yield figures in 2008.

10.5.2 Soil and water resources

The Linthipe river catchment has been altered in ways which affect discharge into the Lake and the quality of its streams. Increased cultivation on marginal lands especially in dambos and along rivers without any soil conservation measures have led to soil loss through erosion.

Basing on the Soil Estimation Model for Southern Africa (SLEMSA) increased intensity of general cultivation and settlements and the degradation of forests between 1994 and 2008 led to significant increase in the proportion of land with high erosion potentials (11 – 30t/ha/yr) and a decrease in low erosion potential areas. However, while there was an increase in cultivated area over the studied period, the expansion was not onto steeper slopes but on the gentler plains and river basins.

Farm level and watershed management technologies would effectively reduce the proportion of land with high erosion potentials and also increase proportion of areas with low erosion potential.

10.5.3 Fisheries resources

Current and previous studies agree that sedimentation is having an impact on species richness in Lake Malawi. Numbers of potadromous fishes (fishes that migrate between the Lake and its tributary rivers), have declined dramatically probably due in at least part to increased sediment loads and siltation in the rivers.

The impacts on the valuable inshore fisheries resources, has negative socio-economic consequences for fisher folk communities and the local economy.