Economic Valuation Assessment of Land Resources, Ecosystems Services and Resource Degradation in Tanzania

Final Report

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EXECUTIVE SUMMARY

Background

The management of land resources is the basis for the livelihoods of most of the world's poor people and a key part of the national economy throughout the developing world. The contribution of the land resources to the national development and the potential of these resources for poverty reduction and sustainable development are too often not recognized. Review of secondary data has shown that attempts to undertake economic valuation of land resources are very limited, indicating that such work is not fully done in Tanzania. Such valuations are particularly important in facilitating sustainable land management (SLM) practices.

Methodological approaches

The study involved a diversity of methodological approaches, including desk review, stakeholder consultations, focus group discussions, and field observations. The exercise involved review of studies that have recently been conducted in the areas of deforestation and rural livelihoods; land degradation and farming; ecosystem valuation; including experiences from other countries. ***Stakeholders' consultations*** were conducted to fill information gap identified during the desk review. Another checklist was used for ***Focus Group Discussions*** with representatives from communities and village governments. The emphasis was to generate evidence to support sustainable land management policies and investment based on demonstrating their existing and potential contribution to national development and poverty reduction. ***The Market Price Valuation Methods*** was used in the economic valuation of land use options along with key economic activities undertaken by communities. This method is best adopted when natural resources are transacted in formal markets. The total amount of Carbon stored in any ecosystem was accounted by the Above Ground Biomass (AGB), Below Ground Biomass (BGB) and the Soil Organic Carbon. It is estimated that the ratio of the vegetal carbon stock and soil organic carbon is 40 to 60 respectively.

Major findings

Land use cover types in Tabora Region

Tabora region has a total surface area of 76, 663 km^2 of which 76,151 km^2 (99.3%). The land is divided into different cover and use types such as forest and woodlands, agricultural land, water bodies, grasslands used for grazing, game controlled areas, among others. Findings indicate that the largest part of the region is under woodlands of different kinds, followed by wetlands or swamps and then land under cultivation.

Woodland and productivities

Many products are obtained from forests and woodlands, both from managed and non managed forests and woodlands. Honey and beeswax are the major products contributing to the local economy as indicated by their higher monetary values. Building poles, charcoal, and timber seem to also contribute considerably to the local economy. Degradation of such resources may thus have many negative impacts on the local economy. Other resources were not easy to quantify but seem to have lower market values, which could explain the difficulty in their valuation. The roles in the local livelihoods were however considered to be significant. At the village level

the three most important forest products include fuel wood, timber and other wood (building materials), and honey.

Agricultural land and productivity

Generally there has been an indication that agricultural productivity has declined over the ten years in most villages in Tabora region, especially where traditional farming is still being practiced. The major exception is the villages that are under the Millennium Village Project, in the case represented by Mbola village where improved management of agricultural land is practiced. The difference in productivity between the traditional and improved production practices is in this case regarded as the cost of land degradation.

The highest cost of land degradation was observed in paddy production followed by maize, groundnut, cotton and pulses respectively as demonstrated in Figure 2. Reasons for land degradation identified include continuous cultivation without sufficient addition of nutrients, and poor land management practices. The overall decline of productivity in almost all crops raises a concern for sustainable land management initiatives. The cost of land degradation associated with cultivation of food crops appears to be higher compared to cash crops, possibly due to much lower net returns per unit area in the former compared to the latter. Crops sensitive to land degradation appear to be sweet potato, cassava and paddy which have demonstrated steady decline of productivity over the years. To increase and sustain productivity require appropriate intervention strategies such as use of appropriate soil fertility and water management practices.

Productivity of Water bodies (fisheries resources)

Most fishes in the Tabora region come from Malagarasi wetlands where lakes such as Sagara are situated. A small proportion of the fish are harvested from Ugalla River. However, because the river is within a protected area, the Ugalla game reserve, fishing in that river is somewhat restricted. In terms of fish catches, production increased from 2006 and reached its highest number in 2007 and in subsequent years declined progressively. The reasons for the increased fish catch, and eventually their values, were the sustainable management practices of Malagarasi Muyowosi wetland which were put in place once the area was under Ramsar.

Biodiversity value

The contribution of biodiversity to the value of Tabora land is the highest and this is due to the fact that much of the land in the region is designated as a conserved area. It has a value of US 65 **billion** very close to the contribution of carbon stock which is 44 **billion.** This is an area where much of the effort needs to be put in order to conserve different biodiversity present in the region.

The study recommends that although woodlands have shown to have the highest economic value in terms of biodiversity and carbon stock values from other landuse types needs to be sustained as they play significant impacts on community livelihoods. A mechanism needs to be in place to ensure that communities benefit from woodlands in different ways, such as implementation of REDD projects.

LIST OF ABBREVIATION

CBFM	Community Based Forest Management
DADPs	District Agricultural Development Plans
DAFTs	District Agricultural Facilitation Teams
DALDO	District Agricultural and Livestock Development Offices
FAO	Food and Agricultural Organization of the United Nations
FBD	Forestry and Beekeeping Division
FGD	Focus Group Discussion
FYM	Farmyard Manure
GHG	Greenhouse Gases
GDP	Gross Domestic Product
HASHI	Hifadhi Ardhi Shinyanga
HADO	Hifadhi Ardhi Dodoma
IAS	Invasive Aliens Species
ICRAF	International Centre for Research in Agroforestry
IFAD	International Fund for Agricultural Development
IRA	Institute of Resource Assessment
MDGs	Millennium Development Goals
MKUKUTA	Mkakati wa Kukuza Uchumi na Kuondoa Umaskini (National Strategy for Growth and Poverty Reduction)
MNRT	Ministry of Natural Resources and Tourism
NAP	National Adaptation Programme
NEP	National Environmental Policy
NGOs	Non Governmental Organization
PADEP	Participatory Agriculture and Development Empowerment Project
REDD	Reduced Emission from Deforestation and Degradation
SEI	Stockholm Environmental Institute
SFM	Sustainable Forest Management
SIMMORS	Sustainable and Integrated Management of Malagarasi – Moyovozi Ramsar Site
SLM	Sustainable Land Management
TShs	Tanzania Shilings
UN	United National
UNCCD	United Nations Convention to Combat Desertification
URT	United Republic of Tanzania
US$	United State Dollars (IUS$=1500 Tsh)

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1.0 BACKGROUND

1.1 Introduction

The management of land resources is the basis for the livelihoods of most of the world's poor people and a key part of the national economy throughout the developing world. The contribution of the land resources to the national development and the potential of these resources, where SLM is practiced, for poverty reduction and sustainable development are too often not recognized. The global mechanism has in collaboration with international research organizations such as SEI and CAB International launched a global initiative on analysis of the values of land resources and cost of land degradation. The emphasis has on finding evidence to support SLM policies and investments, based on demonstrating their existing and potential contribution to national development and poverty reduction.

In view of the above, the Institute of Resource Assessment (IRA) of the University of Dar es Salaam was contracted with IFAD to support the Global Mechanism in assessing the economic value of land and costs of land degradation in Tanzania. The emphasis was on generating evidence to support sustainable land management policies and investments, based on demonstrating their existing and potential contribution to national development and poverty reduction in a Tanzanian context. The assumption is that sustainable land management is an underpinning requirement for sustainable development and poverty reduction and conversely, that existing trends in land degradation are jeopardizing the prospects of Tanzania for achieving its national development priorities and the MDGs. The specific objectives for this assignment are as indicated in the contract. Main deliverables including an approach report inclusive of work plan which has to be followed by draft and final economic valuation reports respectively. This approach paper is submitted to describe characteristics of selected pilot areas in Tanzania including selection criteria, social economic and biophysical characteristics, major land uses, kinds of degradation and current status. The report addresses issues of land degradation in Tabora Region. This region is among those which are undergoing rapid transformation from natural ecosystems to other forms of land uses leading to various levels of land degradation. The report also describes in detail how economic valuation of land has been conducted.

1.2 A review on economic valuation of land in Tanzania

Review of secondary data has shown that attempts to undertake economic valuation of land resources are very limited indicating that such work has not been comprehensively done in Tanzania. What exists is general information on land issues including land degradation and very little information on specific studies on valuation for small projects or programmes. Of major concern in Tanzania is the valuation of forest resources at county level including a study by FAO in 1992 which valued the production of non-wood forest products (NWFP).

1.2.1 Land rights and land value in Tanzania

Tanzania's first comprehensive tax legislation came at the start of the Second World War which defined real property income as income from dividends or interest, royalty or rent. It is nevertheless remarkable to note that prior to 1958, the Tax Act imposed a tax rent minus any expenses incurred in the production of the income. The law has

undergone several amendments concerning taxation of land rents (Abiama, 2011). In the 1920s Tanzania had a very high standard of surveying and registration process thereby making statutory taxation of property rates possible. In 1955, site-value rates were introduced in Dares-salaam and the eleven autonomous urban councils while rating in other parts of the country was conducted by government appointed councils. Each of these autonomous councils including Dar es Salaam City council was required to set up its own rate applicable to the unimproved land values only but subject to approval by the minister of the local government. The rates ranged from 2.5% to 3.5% while certified government valuers were to undertake revaluations every five years (Abiama, 2011).

Records show that between 1959 and 1964, average land rent contributed 4.1% to Tanzania's GDP. This gain was however reversed when Tanzania adopted Socialism in 1967 which brought the nationalization of all private property. Section 8 of the Tax Act under which land rents were brought into the concept of income was abandoned (Abiama, 2011).

1.2.2 Land use patterns and land policy in Tanzania.

Tanzania is an East African country with a surface area of 94.3 million hectares of which 22 million ha (23%) is allocated to reserves, including National Parks (4.2 million ha) Game Reserves (7.7 million ha) and Forest Reserves (10.1 million ha). Tanzania has the largest share of land resources allocated as reserves of any country in sub-Saharan Africa (Abiama, 2011). The gross area cultivated/planted annually is only about 5.1 million hectares which is only about 5% of the surface area of Tanzania. The other arable land but not cultivated is 10 million ha, much of it used as pasture. Within the reserves, there is an additional 4 million hectares suitable for cultivation (Abiama, 2011). Agriculture in Tanzania is dominated by small holder farmers (peasants) cultivating average farm sizes of between 0.9ha and 3.0ha each. Taxes from these farmers contribute very little to the total annual revenue (Abiama, 2011).

Since Tanzania attained its political independence in 1961, it has been realised that there was a need to develop a coherent and comprehensive land policy that would secure land tenure and enable proper management and alienation of land in urban and rural areas and provide a clear position on customary land tenure in the light of profound economic and social reforms (Abiama, 2011).

In May 1995, Tanzania adopted a new land policy reversing the socialist policies of past decades. This policy came about after careful research and public inquiry into land matters initiated in 1989. The result was the reintroduction of private property rights and legalized market alienation (right to assign or transfer ownership) of land. The land policy also strongly recommended the introduction of land value rating not only as efficient source of revenue for local governments, but also as the preferred policy instrument for managing the development of urban sites and speculative land acquisition in Tanzania. The country should now move ahead with full implementation of land value capture policy (Abiama, 2011).

In May 2001, the laws passed by parliament in 1999 became operational. One of the fundamental principles of those land laws is, "to ensure that land is used productively

and that any such use complies with the principles of sustainable development" (Abiama, 2011).

1.2.3 Economic value of NWFP in Tanzania

One of the main preoccupation of rural people in Tanzania, especially in the savannah woodland of Tabora and semiarid zones like Shinyanga, Mwanza, Singida, Dodoma, parts of Arusha and Kilimanjaro regions where animal husbandry forms a major source of income is to have enough fodder to meet food scarcity especially for their livestock. To a greater extent, the forage needs for their huge stocks of cattle, goats and sheep still is afforded from the wild sources - the grasslands and forests close to their habitats. During the dry season, grazing animals may have only branches and leaves of fodder trees to live on. In some of these areas, we also find higher concentrations of wildlife in the parks and game reserves which depend upon dry season browse for their survival. Crude protein contained in the leaves of some trees, makes certain tree species very palatable for animals. Several species of *Prosopis*, *P. juliflora*, *P. chilensis* produce pods that are highly palatable and nutritive, and the leaves are eaten by cattle. These multipurpose trees also yield poles and timber and can be established on saline soils in arid areas where other fodder plants are rare. Pods and leaves of browse species of Acacias - *A. nilotica*, *A. arabica*, *A. tortilis*, *A. senegal*, *A. farnesiana* and *Faidherbia albida* are readily eaten by both cattle and wildlife populations, and these species can be established in semi arid zones on commercial basis. *Tamarindus indica*, with its wide, rounded crown and drooping branches provides both shade and fodder crop to grazing animals in dry savannah sites. However, in densely populated highland areas of Arusha, Kilimanjaro, Southern highlands, Usambaras, Uluguru mountains and Kagera, fodder trees and shrubby species which have high production potential and produce good quality fodder are cultivated. *Leucaena leucocephala*, *L. diversifolia*, *Pithecelobium dulce*, *Acacia farnesiana*, *Erythrina spp*., *Senna siamea*, *Grevillea robusta* and *Prosopis juliflora* are planted, sometimes as green hedges (living fences). These species are also useful for agroforestry activities as soil conservation and nitrogen fixing species.

Tree fodders may complement, but will not replace herbaceous fodder species, such as elephant grass, in montane areas where zero-grazing in animal husbandry is largely practiced. Selling of fodder crops in these fertile and densely populated areas is a lucrative business at community level. In their review of the economic aspects of Tanzania's forestry, Kowero and Hofstad (1989), noted that estimated a theoretical total annual output from fodder crops of about 900 m Tshs.

1.2.4 Economic value of pastoralism in Tanzania

Policies dispossessing pastoralists of their land – especially their best lands on which high productivity and resilience depends – and converting it to other uses (conservation, irrigated commercial agriculture) are perpetuating a vicious cycle of increasing poverty, resource conflict and environmental degradation that reinforces the very preconceptions and misunderstandings surrounding pastoralism as a livelihood system. Enduring perceptions of pastoralism as an economically inefficient and environmentally destructive land use system coupled with the absence of a dynamic economic valuation framework to assess the contribution of pastoralism continues to justify the appropriation of pastoral land for other uses (IIED, 2011).

1.2.5 Valuation of Ihefu Wetland in Tanzania

Valuation of the Ihefu Wetlands was part of the initiatives to understand the value of wetlands and water catchments of Tanzania. TheIhefu wetlands forms part of the Usangu plains in Tanzania that are important both to the local community and are national resources providing water that generates over 65% of Tanzania's hydropower. In 2007, the government annexed Usangu Game Reserve with Ruaha National Park, making it 20,226 km^2 the largest National Park in Tanzania and one of the largest in Africa. The process initiated by the government aimed at protecting the Ihefu wetland and the Great Ruaha River with associated catchment areas and biodiversity (UNPEI, 2006). Prior to this the Usangu game reserve had come under threat due to an influx of fishermen, livestock herders and crop farmers (mainly 2 irrigated rice) (UNPEI, 2006). Weak management arrangements had led to severe degradation and a decrease in water availability downstream in the Great Ruaha and Rufiji Rivers (UNPEI, 2006).

In this study all villages surveyed, the main economic activities include agriculture and livestock keeping. Crops grown include rice, maize, vegetables, millet, ground nuts, potatoes, sunflowers, sorghum etc. For the livestock, the common animal reared is the local cattle, goats and sheep. Other economic activities (in very small scale by some households) including sale of firewood, charcoal, furniture, local brew, leasing of farm land and supplying casual labour to estates. The analysis showed that, household economy is totally dependent on agriculture, followed by livestock keeping. Any disruption from these activities would have detrimental effect to the living condition of majority households in the study area as well as other areas which are supplied by food crops from the study area (UNPEI, 2006).

1.3 Land degradation in Tanzania

Global efforts to address land degradation and desertification as a problem and measures to control and combat it have been recognized and way back to the 1970s. for instance, in 1977, UNEP organized a UNCCD in Nairobi, Kenya. The meeting called upon affected countries to prepare and adopt the Plan of Action to Combat Desertification. Tanzania participated and made an effort to prepare a National Action Plan (NAP). Unfortunately the Plan of Action did not meet the expectations due to various reasons including; i) lack of financial resources; ii) lack of adequate coordination and; little participation of the affected communities in planning, designing and implementation of the plan. In 1992, UNCED in Rio de Janeiro, Brazil the conference noted that desertification was still a major problem threatening the sustainability of dry lands and thus demanded concerted efforts in solving it. The UN General Assembly established Intergovernmental Negotiation Committee on Desertification (INCD) which consulted and negotiated the convention amongst affected countries to produce the Convention. This was signed in April 1994 in Paris, France and the United Republic of Tanzania ratified it in June 1997 and the NAP prepared in 1999 was reviewed in 2004.

Efforts to combat land degradation in Tanzania started before independence. The problem of land degradation was recognized way back in 1900. It was during that time when, the colonial government initiated a Soil Erosion Committee to advice the government on the cause of erosion and actions required. In 1930's, anti-erosion rules were publicized to protect slopes and water sources, and control bush fires

while introducing cover crops. In 1940's the government adopted a Scheme approach to deal with land degradation. For example the Sukumaland Resettlement Scheme (1944-1958) covered the present Mwanza and Shinyanga regions. This was designed to educate people on proper land use methods, conservation of crop residues for dry season fodder and manure, gully stopping/plugging, live hedge, resettling excess population and livestock on prepared expansion areas. These are a few cases to mention.

After independence to date a number of strategies have been in place to combat land degradation/desertification. For example in 1970s the Soil Conservation Programme in Dodoma (HADO) started as afforestation and engineering project aimed at preventing further land degradation and rehabilitating degraded parts of the landscape in Dodoma especially the Kondoa Irangi highlands. The soil conservation programme for HASHI started as a follow up of a national conference held in Shinyanga in 1984 on "Environmental Conservation through tree planting". This programme aimed at encouraging and involving the people of Shinyanga in environmental conservation measures to mitigate the adverse effects of land degradation and to improve their standard of living. The programme capitalised on education, awareness raising and use of indigenous knowledge to achieve its targets.

Despite the above efforts, little achievements were realised. In order to ensure that SLM strategies are effectively implemented in Tanzania the following are key issues ought to be considered.

- Prioritize SLM as an area of critical importance especially now as land is increasingly affected by other calamities/emerging issues e.g. Climate Change.
- Need for an innovative integrated financing strategy that will ensure availability of resources from all sources (international/domestic/public and private) and sectors that are stakeholders in the issue of land.
- Aligning the National Action Programme to combat desertification to the national Ten year strategic plan and framework to enhance the implementation of the Convention (2008–2018).
- Mainstreaming SLM issues in Development plans and gives priority in allocating resources.
- Continue implementing current strategies/programmes and up-scaling these initiatives to cover a large scale.
- Continue to work with DPs/Conventions/GM and other UN and other international organizations to achieve SLM.

This project therefore is part and parcel of the implementation of the NAP in Tanzania towards sustainable investment on land and combating desertification.

2.0 DESCRIPTION OF THE STUDY AREA

Tabora Region is located in the Central Western part of Tanzania with an estimated population of 2,375,000 in 2010, most of whom live in rural areas and depend on land resources for their livelihoods. The region is endowed with substantial natural resources. The area leads the whole country in the production of Virginia Tobacco,

is the largest producer of groundnuts and is famous in the beekeeping industry, producing substantial quantities of honey and beeswax for local and international markets. Tabora Region also has an abundance of both hard and soft wood forests. In Tabora, about 76% of the population are farmers and agriculture is the largest single sector in the economy, directly producing about 80 percent of Tabora Region's wealth. The main cash crops are tobacco, cotton, which are mainly grown for export markets, and paddy. Principal food crops are maize, sorghum, cassava, sweet potatoes and legumes. Tabora Region's GDP per capita was $229 in 2005, significantly lower than the national average which was $327 in 2007 and Tabora ranked 14th out of Tanzania's 21 regions with regard to household incomes in a 2007 survey. Livestock keeping is the second predominant economic activity which, if properly exploited, can contribute significantly to the region's economy. Fishing activities are limited and are mainly confined to Lake Sagara and Ugalla River. Industries, trade and mining activities are carried out at a small scale.

Tabora region is in the Western part of Tanzania and is reasonably homogenous regarding topography and temperature. There are some variations in the region that reflect differences in rainfall, topography and human settlement patterns. The dominant area is the **miombo woodlands**, which covers much of the region and is characteristic of similar areas across Southern Africa. This is generally an open woodland with grasses for ground cover and contains a variety of tree species. The soils are of medium fertility when first cleared of woodland but both soil structure and fertility decline under cropping. Farming is mostly small holders with a mixture of food and cash crops, livestock rearing and other activities.

The western fringe of the region generally has higher rainfall and lower population densities than other parts of the region. It is mostly wooded with some grasslands and wetlands, but tsetse flies are endemic, which restricts livestock rearing. In contrast, the north-eastern zone is more densely populated with cotton a significant crop and a large cattle population. An area that includes the Wembere Plains which is extensively used for dry season grazing, is adjacent to the north-eastern zone. Natural vegetation has largely been cleared in the north-western zone but there are broad belts of scrub on the poorer soils. Crops are paddy, maize, groundnuts and some cotton and the area has a large cattle population.

Woodland is the natural vegetation over most of the region and, despite clearances over many years, still covers 58% of Tobara's land surface (see figure 1, table 1). The woodlands can be divided into two groups: Miombo woodland and *Acacia, Cambretum* and *Albizia* species. Bushland and bushed grassland, typically degraded and heavily grazed woodlands, cover much of the northern and eastern parts of Tobara, whilst large areas of "thorn-thicket" are found in the lowlands bordering the Manonga and Wembere valleys and dense, impenetrable deciduous thicket of multi-stemmed shrubs known as Itigi thicket occurs in the east of the region. Wooded grassland is found in mbuga and consists of tall coarse grasses with less than 50% of trees while grassland is found in the wetter mbugas which are invariably flooded for long periods during the wet season within areas of wooded grassland and on the edges of swamp vegetation. Other land uses include agricultural land and human settlements.

In Tabora Region agriculture, livestock rearing and other land management practices has resulted in different forms of land degradation, including deforestation, loss of soil fertility due to tobacco farming, wetland degradation due to extensive livestock keeping, loss of biodiversity such as fish and wild animals due to illegal fishing and hunting. The rate of land degradation is feared to be high in some areas and is threatening the sustainability of the land resource base in these areas but there is little accurate data on the exact for and extent of these land degradation pressures.
This study was implemented in the Western part of Tanzania which to a large extent represents the miombo woodlands. The area covers Tabora region which have various ecosystems including woodlands, wetlands, agricultural land, water and are all subjected to different social economic activities and hence services to community livelihoods and ecosystems. The economic valuation of land was made at Regional scale followed by specific case studies in selected villages including Itebulanda, Maboha and Mbola villages representing different land-use units, availability of different ecosystem services and interventions to address land degradation.

2.1 Ecological zones of the study area

Tabora region is reasonably homogenous regarding topography and temperature. However, it has major ecological differences which combined with other factors is divided into five economic zones as follows.

2.1.1 Western Fringe Zone

This area which follows the western and south-western boundary of the region has a high rainfall of over 1000mm, is sparsely populated and varies in elevation from 1000 to 1500 metres. It is characterized by mainly flat and featureless topography with the area gradually sloping away to the river flood plains in the west and south adjacent to the Ugalla and Malagarasi Rivers and Lake Sagara.

Soils vary from reddish sandy loams on the top of the ridges through grey sandy loams down to heavy black alluvial soils on the flood plains. The vegetation on the better drained areas is composed of *Brachystegia - Jubernadia* woodland with an undercover of grassland composed mainly of *Hyperrhenia* with *Echinocloa* on the river and lake edges. It is an area of great potential but development has been limited by the low population level as a result of the presence of the tsetse fly and poor road communication. The cropping pattern is characterized by subsistence crops such as maize, cassava, beans, tobacco and paddy being grown in the wetter areas. Cattle population is low due to the presence of the tsetse fly. Fishing is concentrated on Lake Sagara.

2.1.2 The Miombo Zone

This zone is the most extensive in the region and covers about 6,000,000ha. Rainfall varies from some 700 mm in the east to over 1000 mm in the west. Most of the zone is gently undulating with occasional granite hills emerging from the ridges, and low swampy depressions forming the drainage lines between the ridges. Elevation is generally between 1000-1500 metres with some areas on the eastern border of the Zone rising to 1800 metres.

Soils on the upper slopes are mainly reddish-brown sandy loams underlain by light sandy clays while soils in the lower slopes are drained dark grey sandy loams with black clays in the depressions. The dominant trees are *Brachystegia* and *Jubernadia*

with underlying grass cover of *Hyperrhenia*. The soils are of medium fertility when first cleared of woodland but both structure and fertility decline under cropping.

Cropping is largely confined to tobacco, maize, cassava and beans with paddy being grown in “mbugas”. Saw milling (of indigenous species) and extensive beekeeping are features of non-settled areas.

2.1.3 The North East Zone

This zone is located in the north - east corner of the region bordering on the Manonga River to the north and Wembere plains in the east. Rainfall is between 700 mm in the east to 850 mm in the west. The zone covers an area of about 350,000 ha. The topography is gently rolling with poorly defined drainage lines. This zone is densely populated mainly due to immigration from the more densely settled regions to the north.

Soils are mainly black clays or clay loams (black cotton soils) which make the zone an important cotton growing area with maize and sorghum being grown as food crops. There is very large cattle population and cattle are extensively used for ploughing.

2.1.4 East Central Zone

The zone is in the North East of the region between the North East Zone and the Miombo Zone and includes the Wembere Plains. It is an area with more incised drainage than the rest of the region with the exception of the area to the extreme east which is the flood plain of the Wembere River. Altitude varies from 1000 to 1800 metres and rainfall from 500 mm to 800 mm.

Vegetation and soils are mixed in the western portion of the zone. The soils are sandy loams with the vegetation consisting of belts of Miombo Woodlands interspersed with *Cambretum* bush. To the East, Acacia species become dominant on the heavier soils, while the Wembere plains consist of grassland with small area of Acacia. The zone has pockets of tsetse fly infestation. Cropping is confined to cotton, maize, sorghum, groundnuts and cassava. The north of the zone has a large cattle population with the Wembere plains being extensively used for dry season grazing.

2.1.5 The North West Zone

This zone is situated on the North, West of North East Zone. The topography is gently rolling with broad “mbugas”. The rainfall varies from 700 mm to 1000 mm and altitude from 1000 to 1500 metres. The soils vary from dark clays in the mbugas to light sandy soils on the ridges. Natural vegetation has largely been cut out but there are broad belts of scrub cambretum on the poorer soils. Crops are paddy, maize, groundnuts and some cotton. This zone has a large cattle population.

2.2 Major land-use/cover types

Major land use/cover in Tabora region consists of upland vegetation which includes woodland, bushland thicket, grassland; lowland or wetland vegetation consisting of wooded grassland and swamps (more detail is provided in Chapter Four). Woodland is the natural vegetation over most of the region and can be divided into two groups: Miombo woodland and *Acacia, Cambretum* and *Albizia* species. Bushland and

bushed grassland considered being a degraded form of a number of different vegetation types which have been cleared, browsed and selectively grazed for many years are the most widespread types in the North East. Large areas are covered by “thorn-thicket” which is especially extensive on the lowland bordering the Manonga and Wembere valleys. A dense, impenetrable deciduous thicket of multi-stemmed shrubs known as Itigi thicket occurs in the east of the region. Wooded grassland is found in mbuga and consists of tall coarse grasses with less than 50% of trees while grassland is found in the wetter mbugas which are invariably flooded for long periods during the wet season within areas of wooded grassland and on the edges of swamp vegetation. Other land uses include agricultural land and human settlements.

2.3 Description of degree of land degradation

In Tabora region, several socio-economic activities interact including agriculture (crop and livestock) systems bringing different forms of land degradation including deforestation, loss of soil fertility due to tobacco farming, wetland degradation due to extensive livestock keeping, loss of biodiversity such as fish and wild animals due to illegal fishing and hunting. The rate of land degradation is proceeding at high rate and this is threatening sustainability of different natural resources. The most serious environmental impact of the tobacco crop probably remains the deforestation it induces in the surrounding areas. Tobacco growing has contributed significantly to vegetation degradation in the western Miombo ecosystem, including deforestation while opening new farms and also the associated fuelwood collection for tobacco curing.

3.0 METHODOLOGY

3.1 Selection of study area

Initially, this study was proposed to be implemented in three regions of Tanzania namely Singida, Iringa and Tabora. Due to time required and magnitude of funding, it was finally agreed to be conducted in the Tabora region. The reason for selecting this part of the country was due to the fact that the region represents a wide range of ecosystems as indicated earlier and also a number of studies related to land management have been conducted in the region. For verification purposes three villages were identified for site visits and collection of more first hand information that formed the basis for computation and estimation of values.

3.2 Criteria for selecting pilot villages

It is certainly clear that all the communities are dependent on the land resources in various ways for their livelihoods. Likewise, impacts of community activities on ecosystems integrity are variable. It is on the basis of biophysical and socio-economic characteristics that the region was selected for this study. Thus, the choice criteria used has included landscape characteristics, socio-economic set-ups, diversity of livelihood activities, and levels of land degradation and external interventions. The villages selected were Maboha, Itebulanda and Mbola as discussed below.

3.2.1 Maboha Village

The first unit is that characterised by wetlands, grasslands, bushlands and woodlands. This unit encompasses Malagarasi-Moyowozi wetlands and surrounding vegetation communities. It is in this unit that there are various livelihood activities such as fishing, tobacco farming, and production of other food crops. However, the area is experiencing influx of livestock searching for forage and water particularly during the dry season. Such high livestock concentration is increasing wetland degradation. Maboha Village in Urambo District was selected as a representative village for detailed study.

As already pointed out the wetland supports a number of vulnerable or endangered species including the Shoebill (*Balaeniceps rex*), Wattled Crane (*Bugeranus carunculatus*), African Elephant (*Loxodonta africana*), Sitaunga (*Tragalephus spekei*) and African Slender–snouted Crocodile (*Crocodylus cataphractus*). *Pollimyrus nigricans* and *Bryconaethiops boulenger* are some of the rare fish species. In addition there are a number of endemic fish species in the system whose conservation status has not been determined.

The Malagarasi-Moyovozi Wetland Ecosystem plays an important hydrological role as well having many important socio-economic values. Some of the most important include harvesting of wetland related products including fish, forest products, medicinal plants, honey and wildlife. Other values of importance to the local communities include flood control, water supply and dry season grazing. Large numbers of fishing and bee-keeping camps operate throughout the Ramsar site during the dry season (July to December). Permanent fishing villages are present around some of the lakes.

3.2.2 Itebulanda Village

The second unit is that characterised by extensive miombo woodland. It is in this unit that tobacco cultivation is being extensively practised. Other crops grown are food crops like maize and beans. Tobacco cultivation is contributing to deforestation through clearance of vegetation for crop production and fuel wood for tobacco curing. Itebulanda is a village that is situated close to Urambo District headquarters, thus has an urban influence. It is in this village that both charcoal making and beekeeping are practiced. However, the area is experiencing conflicts between these two forest resource uses.

3.2.3 Mbola Village

Mbola, Isila and Mpenge are part of the Mbola Millenium village cluster where heavy development investments have been made thus leading to enhancement of community livelihoods. Subsistence farming is the main economic activity, consisting mainly of rain-fed agriculture and the production of local livestock breeds. The village represents the maize-mixed farming system in the Miombo woodland savanna agro-ecological zone. The village has two distinct seasons, a rainy season between November and April and a dry season for the remaining part of the year. In recent years, the rain has become increasingly erratic.

The village land holdings range between 1 to more than 15 hectares per household, with 1.4 being the most common size. The main food crops are cassava, sweet potatoes, paddy rice, fruits and vegetables. The main cash crop is tobacco, which is cultivated by 68% of the population. Beekeeping and rice growing are also important activities in the region. Unreliable rainfall and poor soil fertility are the major hindrance to farm production in the area. Low and declining crop yields are posing problems of food insecurity resulting in hunger and malnutrition in most households, particularly affecting children.

The main development challenges in Mbola before the millennium initiative included the high rate of environmental degradation resulting from poor crop management practices, declining agricultural production and destruction of the Miombo woodlands for fuel wood used in the tobacco industry. Overgrazing and expansion of agricultural land have also contributed to the decline of land productivity. In addition, roads are in a poor state, thus limiting easy access to markets. There is a general lack of basic infrastructure for health and education.

Development intervention in the Mbola village has led to tremendous increase in agricultural yields thus enhancing community food security. It was reported during fieldwork (IRA, 2010) that maize production has increased from about 3 bags to 30 bags per ha. This has meant the majority of farmers abandoning tobacco farming and charcoal making. They get food and incomes from sale of high value crops. Alongside food security efforts, the Mbola Village Program is working with villagers to encourage environmentally-sustainable farming practices such as planting nitrogen-fixing trees throughout the cluster. Additionally, more than 5,900 of Mbola's 6,000 farmers have diversified their crops to include high-value crops, such as sunflowers, fruits, and vegetables with the aim of generating a significant income boost for Mbola's farmers.

3.3 The approach used in data collection

In general, the study adopted the methodological approach suggested by Noel and Soussan (2010). The methodology used provided the means to assess several aspects of the relationship between land resources and economic development at Regional and community levels. The methodology (Table 1) used allowed for the investigations to:

- Assess and quantify the ecological characteristics and spatial distribution of **land resources** in the study area, based on the analysis of land cover types at regional level.
- Identify the types, quantities and values of **ecosystems services** from different land cover types and agro-ecosystems categories. This included the estimation of both resource stocks and ecosystems services flows.
- Analyze the extent, severity and location of **land degradation** pressures and risks.
- Assess **trends over time** in the distribution, **values and utili**zation of ecosystems services **derived from land resources** in particular the production of both food and cash crops.

- Analyze the contribution of land resources to **local livelihoods** and national **economic development** and assess trends over time in these relationships.

Table 1. A summary 6 stages and methodologies used in economic valuation of land in this study

STEP	DESCRIPTION	RELEVANT METHODOLOGIES
1	Inception	Consultations, review of exists reports and papers
2	Land cover assessment	Existing landuse cover developed using GIS in 2002
3	Ecosystem services assessment	MA typology Total economic value Use of existing standards Total carbon estimation and costing
4	Livelihoods and economic development analysis	Participatory Rural Assessment (PRA) through discussion with key informants and focus group in study villages
5	Land degradation patterns	Total economic value
6	Sustainable land management options	Total economic value (the case of Mbola)

Source: Noel and Soussan (2010).

The most appropriate methods and sources of information for each of these stages have been elaborated earlier in the inception report (IRA, 2010). Table 1 presents a list of specific methods used in economic valuation of land.

3.3.1 Steps for data collection and economic valuation

The section that follows briefly discusses the methodology used in this study. Given the nature of the tasks it is obvious that single method would not be enough to address all the issues related to ecosystem valuation and land degradation. Literature review, interviews with key resource persons at regional and district levels, and finally focus group discussion (FDG) in case study villages.

3.3.1.1 Desk review

This was carried out to identify and review the existing data which consider aspects of economic value of land and costs of land degradation at national, district and community levels. The exercise involved review of studies that have recently been conducted in the areas that focus on: (1) deforestation and rural livelihoods; (2) degradation and farming; (3) ecosystem valuation (4) related studies from other countries. Specifically, the desk review is expected to provide questions and issues that need to be pursued involving other stakeholders regarding ecosystem valuation and the cost of land degradation as well as community level land use practices that potentially contribute to ecosystem degradation.

3.3.1.2 Stakeholders consultations

This was deliberately conducted to fill information gap identified during the inception period. Consultation was conducted using a checklist (see Annex 1). Stakeholders consulted in are listed below;

1. Regional Agricultural Advisor for Tabora Region
2. Regional Natural Resource Officer for Tabora Region
3. Districts Agricultural and Livestock Officers for Urambo and Uyui
4. District Natural Resource Officers for Urambo and Uyui

5. The Regional Game Officers for Tabora region
6. Program officer, UNDP Mbola Millennium Village
7. Project coordinator, SIMMORNS office in Urambo
8. Regional Catchment Forest officers in Tabora
9. The Town Planner and Coordinator of the Millennium Cities Initiative in Tabora Municipality
10. The Regional Land Use Planning Officer for Tabora region
11. The Regional Fisheries Officer for Tabora region.

3.3.1.3 Focus Group Discussions (FGD)

Given the complexities of the activities related to the ecosystem services, the study team undertook FGD in selected study villages involving representatives from communities and village governments, especially members of community responsible in village environmental and resources management, agriculture as well as social services committees, and with adequate gender representation. In each village the number of participants ranged from 10-15. The checklist used to guide the discussion is in Annex 2)

Among the aspects addressed was the availability of various land based products, including timber and non-timber products. Emphasis was also on how the level of community dependence on and market value attached to such products, especially those that are not unusually comprehensively recorded. Examples here included wild foods such as, honey harvesting, fishing, vegetable, mushrooms and fruits. Non-food forest products of interest included thatch grass, building poles and timber, and ecosystem services such water supply. Efforts were made find out prices attached to these products at the farm-gate, especially for the products that are not in official records.

3.3.1.4 Economic valuation of land resources

In order to assess the value of land use options along with key economic activities undertaken by communities, market price valuation method was used. This method is best adopted when natural resources are transacted in formal markets. This was applicable for products that are extracted from the forest and produced from the cultivated land.

Livelihoods assessment

The focus on this was to investigate the current economic returns of different forms of land use practices and the existing on-farm benefits. To seek the permanent solution to the existing problems of unsustainable land management the study entailed assessment of the willingness of the villagers to participate in various forms of interventions into and land and resources management, such as land conservation.

3.3.1.5 Computation of biodiversity values

Since empirical research on biodiversity values of many ecosystems in the world has not received much attention to date, the monetary values used in this study were obtained from various sources as follows: Barbier *et al*. (1991); Kumari (1995);

Piementel (1995); Simpson *et al*. (1996); Piemental *et al*. (1996); Costanza *et al*. (1997); Ruitenbeck (1988) and Pearce (2001).

3.3.1.6 Computation of Total Carbon Stocks for Different Land Cover Types

The total amount of Carbon stored in any ecosystem is accounted by the Above Ground Biomass (AGB), Below Ground Biomass (BGB) and the Soil Organic Carbon. It is estimated that the ratio of the vegetal carbon stock and soil organic carbon is 40 to 60 respectively. Below ground biomass was estimated by using a simple default value of shoot/root ratio for different forest types as recommended by IPCC (2003). The shoot/root ratio value used for this study was **15**%. Depending on the nature of vegetation, the shoot root may range from **8-20**% of the above ground biomass (Ramankutty *et al*., 2007). This is established based on predictive relationship from extensive literature review as mentioned by (Houghton *et al*., 2001; Achard *et al*., 2002; Ramankutty *et al*., 2007). For the case of this study, the area that is dominated by Miombo woodland, the below-ground biomass was taken to be 15% of the above ground biomass (see account by Mujumba and Lyaruu, 2010).

In order to calculate the below ground biomass, the following steps were followed:

(i) From a known value of the above Carbon stock (denoted as **X**) (calculated based on the number of individual trees/hectare, the below ground C stock was obtained by dividing this value by **15** divided by **100** to give a value **Y**.

(ii) The obtained value **Y** was added to **X** and multiplied by a factor of 1.5 to give a value **Y**. A factor of **1.5** is equivalent to **60/40**, the ratio explained above.

(iii) The obtained value **Y** which is **total soil organic carbon** of the given land cover category.

(iv) To obtain the total amount of the carbon stock for any particular land cover category, the values **X**, **Y** and **Z** were added together to give a value **A**.

(v) The total C sequestration ability of any land cover type on monetary terms was obtained by multiplying **A** by **US$ 17** which is the economic value of **1-tonne carbon**.

4.0 MAJOR FINDINGS

4.1 Major Land use cover types in Tabora Region

Tabora region has a total surface area of 76, 663 km^2 of which 76,151 km^2 (99.3%) is land area. The land is divided into different uses such as forest land, agricultural land, settlement land, water bodies, grazing land, game controlled area, etc. Table 2 shows the land use/cover types with their respective size in terms of percentage. The data in Table 2 indicates that the largest area is under woodlands of different kinds, followed by wetlands or swamps and then land under cultivation. The spatial distribution of these land use/cover types is presented in Figure 1.

Table 2. Land use categories and cover types in Tabora Region (grouped)

Major Land Cover Types	Area (ha)	% Total Area
Bushland	432,968	6
Cultivated Land	892,502	12
Grassland	201,518	3
Permanent Swamp	146,798	1.6
Seasonally Inundated Swamp	1,445,539	19
Plantation Forest	633	0.1
Thicket	94,434	1
Woodland	4,407,791	57
Other, Water, Urban	20,932	0.3
Totals	7,643,115	100

Source: IRA (2002)

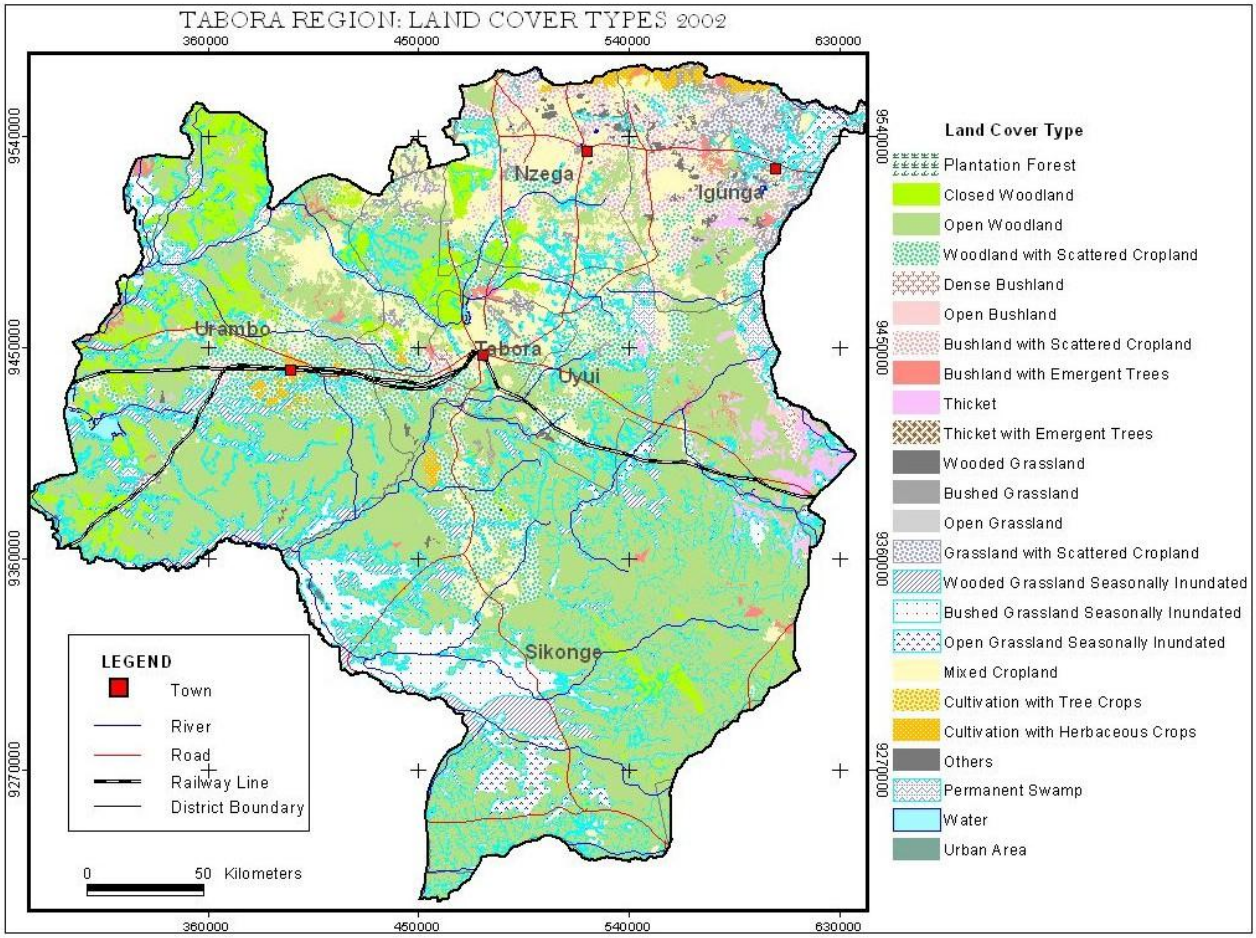

Figure 1. Land use/cover types in Tabora Region
Source: IRA (2002)

4.2 Assessment of Ecosystem Service Values

The values of the land resources of Tabora region and the main ecosystems services they generate have been assessed by a combination of the Institute for Resource Assessment of the University of Dar es Salaam and the Stockholm Environment Institute at the University of York, UK. It reflects an approach that has been developed jointly by SEI and the Global Mechanism of the UNCCD in recent years that is part of a global programme to build an appreciation of the value of land resources in policy processes.

The analysis is based on a combination of secondary data from a wide range of sources within the Southern African region and further afield and a GIS land cover analysis and some primary fieldwork undertaken by IRA in selected villages in the region. This fieldwork, which provided vital data on the livelihoods aspects and household-level provisioning services in particular, and more detailed analysis on some aspects of the work are reported fully in a separate report produced by IRA. The assessment of land cover types and ecosystem characteristics used a GIS system to generate land cover data and this was cross-referenced with ecological studies and information from local informants to determine the ecosystem services characteristics of the different land cover areas.

There is little or no existing data for the study area on ecosystem services values apart from some on provisioning services, so data from studies of comparable areas have been collated and used to generate valuation parameters that have then been applied to the study area. There are of course some uncertainties as to the exact veracity of such measures and all results must be seen as indicative rather than exact, but they do provide a very good and defendable picture of the overall magnitude of ecosystems service values as well as an understanding of the relative values of the different services in the area.

This approach is, of course, only possible where adequate and verifiable data from other sources exists. The exhaustive review of available sources meant that this was indeed the case for most significant ecosystem services in the area but one notable exception to this was the valuation of the biodiversity of the area. A few studies were available for some of the ecosystems present, such as the wetlands, but none could be found for the dominant woodland, grassland and other land cover types. These areas are characterized by a medium level of biodiversity richness and none were described as being of exceptional value in either their species composition or the presence of rare and/or unique indigenous species. In consequence it was decided, with some reluctance, that the data limitations meant that it is not possible to make a valuation of the biodiversity found in the different ecosystems of the study area.

Table 3: Land Cover Types and Ecosystem Services Values in Tabora Region

Major Land Cover Types	Area (ha)	% Total Area	Provisioning Services ($ per year)	Water Regulation ($ per year)	Biodiversity value (S per year)	Tourism & Cultural/Aesthetic Values ($ per year)	Carbon Sequestration Total stock value ($)
Bushland	432,968	6	34,637,440	12,989,040	4,575,462,656	5,195,616	719,484,583
Cultivated Land	892,502	12	280,245,628		58,905,132	10,710,024	1,137,940,050
Grassland	201,518	3	53,978,035	6,045,040	58,992,531	2,418,216	334,872,545
Permanent Swamp	146,798	1.6	29,359,600	88,078,800	1,174,780,355	1,761,576	143,494,045
Seasonally Inundated Swamp	1,445,539	19	338,256,126	578,215,600	11,242,968,680	17,346,468	1,413,014,373
Plantation Forest	633	0.1	101,280	31,650	5,939,439	7,596	587,818
Thicket	94,434	1	7,554,720	2,833,020	632,176,743	1,133,208	156,925,683
Woodland	4,407,791	57	705,246,560	220,389,550	47,568,880,472	52,893,492	40,931,184,903
Other, Water, Urban	20,932	0.3					
Totals	7,643,115	100	1,449,379,389	908,582,700	65,318,106,008	91,466,196	44,837,504,000

Table 3 presents the summary results of this analysis, the full implications of which are discussed in more detail in the following sections. The data shows a complex mix of land cover types which, in turn, will generate a range of ecosystem services values. Whilst woodlands cover over half of the study area, there are also large areas of seasonal or permanent swamps and, at 12%, the area of cultivated land is significantly greater than the national average. Bushlands, grasslands and thickets all also cover large areas, meaning that there is a diverse set of ecosystem services flows across the region that vary spatially but underpin livelihoods and economic processes across the region.

4.2.1 Provisioning Services

Provisioning services, the production of crops, forest products, livestock and other physical goods that are the result of land management, are the largest in value terms and most familiar of the ecosystem services that the land resources of Tabora Region generate (Table 3). The value of these provisioning services is high, at close to **$1.5 billion a year**, and these products are the basis of livelihoods across the region. It is far more than just farming, the provisioning service most widely considered and familiar to policy makers. Indeed, as table 1 shows, the value of outputs from the **cultivated land**, at **$280 million per year**, is less than 20% of the total value of provisioning services. These cropland values come from a range of both subsistence and cash crops, with some such as tobacco and cotton being important for the region and the country as a whole in macro-economic terms as they are valuable exports (a much more detailed analysis of the agricultural production picture in Tabora Region is presented in the IRA report).

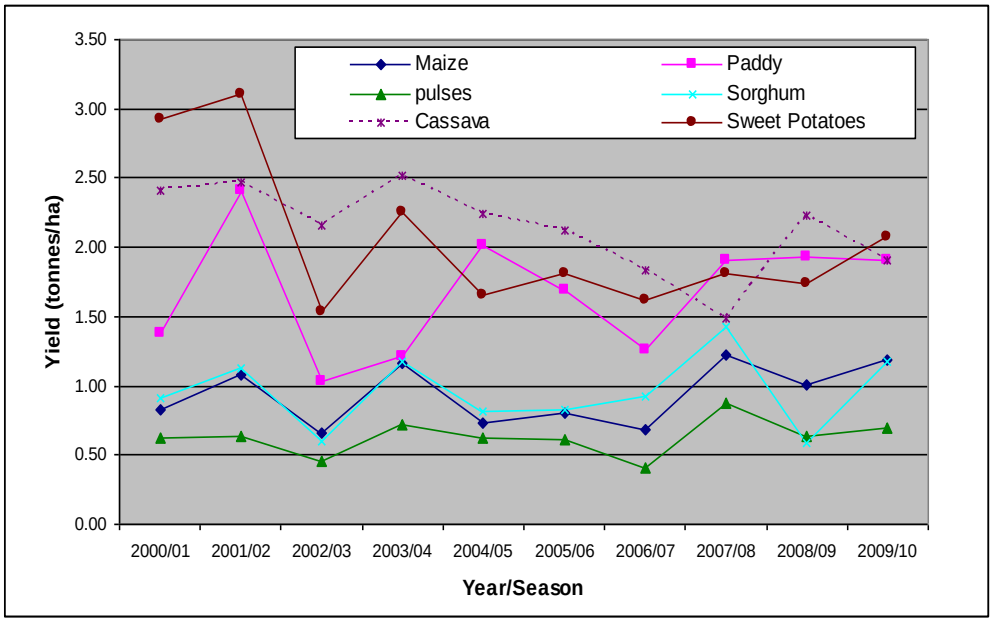

Figure 2. Trends of production for different food crops per ha in Tabora

Crop yields are mostly low and have not improved or have even declined in the last decade (see Figures 2 and 3), as are levels of inputs such as irrigation and improved seeds or nutrients, and the maintenance (or lack thereof) of soil fertility is a serious

issue for many farmers. This is true across the full spectrum of crops and regardless of whether they are produced predominantly for the market or for subsistence consumption. These data cover a period when global crop prices have risen significantly in most cases and during which market incentives to increase production have been extremely high, the overall growth of the Tanzanian economy has been strong and the social and political situation has been stable. The reasons for low and flat levels of agricultural productivity are consequently not found in the external environment but rather reflect the fundamental character of land management practices in farming areas of the region. Production is constrained by the limited availability of key inputs (including labour in many cases) and the inherent limited productivity of land in this region, much of which is not ideal for cultivation.

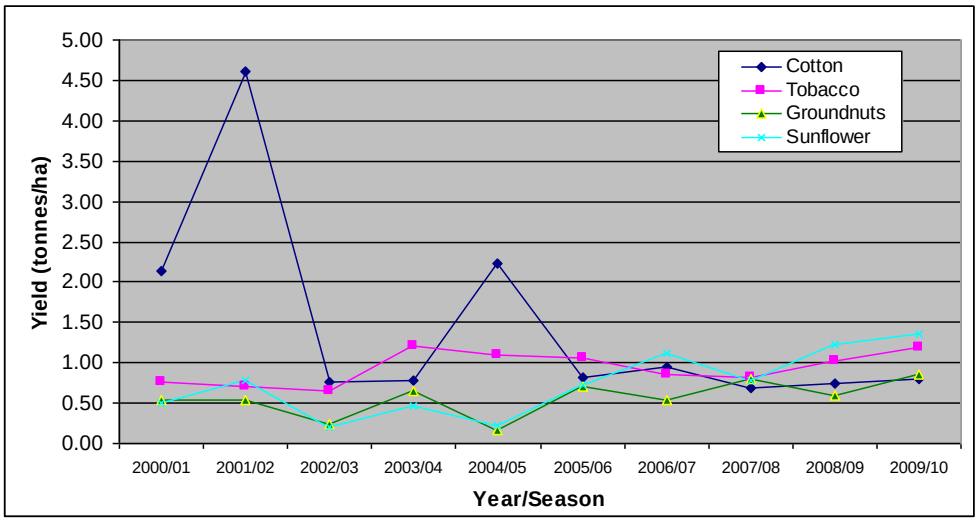

Figure 3. Trends of production for different cash crops per ha in Tabora

Despite these limitations, there is consequently great scope for improving the effectiveness and sustainability of the management of the cultivated land in Tabora Region. This is clearly shown by the results that are emerging from villages that have been identified as Millennium Villages and have received heavy investments and support to improve, amongst other things, agricultural productivity. The fieldwork undertaken by IRA demonstrated that the yields of all crops in these villages have at least doubled and, in the case of maize, have increased five-fold, from an average of 05 tonnes/ha to 2.5 tonnes/ha. Sorghum has increased from 0.3 tonnes/ha to 1 tonne/ha, cassava from 1.5 to 3.5 tonnes/ha, cotton from 0.8 to 2 tonnes/ha and so on. The development packages introduced in these villages include improved seeds, increased use of agro-chemicals, soil erosion control measures, improved water management and other measures. These data are preliminary findings and the cost-effectiveness of the measures introduced has not been assessed but they do clearly indicate the potential for significant increases in agricultural productivity over the current low levels found in Tabora Region.

Woodlands (Table 3) are the most extensive land cover type in the Tabora Region and are consequently the source of nearly 50% of the potential value of provisioning services in the region: it is estimated that the woodlands have the potential to generate provisioning services worth over **$700 million per year**. The figure is based on a valuation of all products, including timber, non-timber forest products such as fuelwood & charcoal, plants for food and medicinal purposes, the use of forests for grazing, building materials etc. It is calculated at a rate of $160/ha/year, a figure that reflects in part data collected in the region but also the findings of a number of studies on the provisioning functions of woodlands of this type in Southern Africa and beyond. The **bushlands and thickets**, which together cover 7% of the region, produce a similar range of products but the lower levels of tree coverage in these areas mean that the rate of service provision is lower. Here it is assumed to be 50% of the productivity of woodlands, meaning that these areas combined generate a potential ecosystem services value of just over **$42 million a year**.

The woodlands of Tabora produce a diverse range of products that are essential to the livelihoods of people across the region. There is some level of commercial timber production but this is very limited and mostly provides wood and logs for local markets. More extensive is the use of timber by local people for construction, fencing and other purposes: these products are invariably collected as and where they are needed. Similarly, woodlands are an important source of foodstuffs, including wild plants and animals as well as honey from wild bees. The woodlands are widely used for grazing in many areas and are the main source of household energy for most rural families in the region through the collection of fuelwood. Such household fuelwood use is mostly not commercialized and does not enter into any economic accounting but it is a vital basic need for local communities and the fuels are mostly gathered on a sustainable basis. There is also some commercial charcoal production, including charcoal that is shipped to Dar es Salaam and towns in other parts of Tanzania.

In most cases this extraction of a wide range of products essential to local livelihoods takes place within sustainable limits and has no implications for land degradation. Indeed, the existing levels of extraction are in general significantly below sustainable levels, reflecting the lack of demand for such products that results from the relatively low population density of most of the Tabora Region.

Livestock production is an important part of the economy of the Tabora Region, with almost all rural households keeping cattle and a variety of other livestock. There are also communities who are predominantly pastoralists, with at least part of the family moving with their herds throughout the year as they migrate to different grazing areas in different seasons. Pastoralism is a major but neglected aspect of the value of land management in Tabora, something that is true for East Africa as a whole:

> "For a substantial slice of East Africa's population — up to 20 million people — pastoralism remains a way of life and an essential livelihood. Yet many policymakers in East African countries have a blind spot regarding pastoralism, and particularly its contribution to economic growth. The problem is partly down

to inadequate information on the comparative advantages of pastoralism over alternative land uses."[1]

Cattle and other large herbivores are grazed on common lands, including woodlands, grasslands and the seasonal swamp areas during the dry season. They typically range extensively over large areas and move from place to place according to the availability of good grazing. Some areas, such as the Wembere Plains, are of particular importance in the dry season when fodder availability is more limited in many other areas. They are the main provisioning value to come from the grasslands and an important source of value from the seasonal swamp (the other values of these areas coming from when they are flooded in the wet season).

The total value of the provisioning services (Table 3) from the **grasslands** is estimated to be around **$54 million a year**, whilst the dry season values from the **seasonally inundated swamps** are estimated to be around **$194 million a year**. Livestock is and will continue to be an important part of people's livelihoods and a key benefit that derives from the management of the land resource base. There are existing and potential future tensions between livestock rearing and other forms of land management, but in most places such tensions are limited and are managed effectively by traditional management systems. The extent to which there could be a significant increase in livestock production over current levels is unknown and would be contingent upon the management regimes through which the production took place. Given the likely growth of national and regional demand for livestock products as economies develop and societies urbanize, this is an issue that needs to be examined carefully in the development of future land management options aimed to preserve and enhance the value of the region's land resource base.

The final important source of provisioning services values from the land resources of the Tabora Region is those derived from **wetlands and aquatic ecosystems**. There are around 150,000 ha of permanent wetland, less than 2% of the total area, but a much larger area, nearly 1.5 million ha or 19% of the total area, of seasonally inundated wetlands that are flooded to varying depths during the wet season meaning that one fifth of the Tobara Region is covered by water for part or all of the year. The exact duration of the seasonal inundation varies from place to place but it is generally for a period of some months, during which the character of these areas is completely transformed and the ecosystem services they generate are notably different.

Wetlands such as those in Tabora are highly productive and generate a range of provisioning services. The most obvious are fish, which are indeed caught in many areas and are an important part of the livelihoods of participating households. Other goods are also produced, such as other animals such as crustaceans and birds that are gathered for food and different types of plants which are used for construction, medicinal purposes and other activities. There have been numerous valuation studies in Southern Africa and other parts of the world and, whilst there is some variation in the results, all show these areas to be highly productive. The characteristics of the

[1] IIED (201) **Briefing Note on the Total Economic Value of Patoralism**, IIED, London.

wetlands in Tabora and of local livelihood systems suggest that the value of these wetlands are likely to be at the lower end of the valuation spectrum and in consequence, with regard to their provisioning services, an average figure of $200/ha/year has been used for this study for the permanent swamps and a figure of 50%, or $100/ha/year used for the seasonally inundated swamps. This produces significant values: nearly **$30 million a year** for the permanent swamp area and around **$150 million a year** for the flooded period for the seasonally inundated swamps to a total of close to **$180 million a year.**

The land resources of Tabora Region consequently generate a wide range and high value of provisioning services that are the basis of the livelihoods of most people in the region and are of economic significance at a national level. In most cases, the management systems through which people gain access to these services are fairly sustainable in character (though there are some problems in some areas) but are low in productivity. The scope for increasing productivity whilst maintaining or enhancing sustainability is great where SLM options are introduced, as witnessed by the changes in output that the Millennium Villages appear to be achieving. The extent to which such experiences can be applied on a wider scale and the external conditions needed to support SLM at the local level are not clear, however, and substantial further analysis is needed before the potential improvements to the flows of provisioning services from Tabora's land resources can become a reality that strengthens livelihoods and stimulates economic development. The potential is there: the challenge is to make this potential a reality.

4.2.2 Water Regulation

As Table 3 shows, the role of land resources in the regulation is a function of critical importance to the economy and development of Tabora Region that generates substantial values. The estimated annual value of water regulation of different sources from different types of land cover, at over **$900 million per year**, is a set of ecosystem services whose significance is rarely appreciated and almost never included in traditional economic calculations of the values of different types of land resources. These water regulation functions take a variety of forms that are of difference significance depending on prevailing socio-economic and environmental conditions in different places. The role of land resources in regulating water resources is of particular importance in areas that have seasonal and variable rainfall, as is the case in the study area, acting to spread water availability more evenly between seasons and limiting the potential onset of extreme events such as floods and droughts in areas that would be substantially hit but such events.

In the study area, nearly 75% of these values (over $666 million) are generated by the 20% of land that are permanent or seasonally inundated wetlands. This is not surprising, as these areas, and the seasonal advance or retreat of the flooded area, are the main natural mechanism for regulating water flows throughout the region. These figures were based on an extensive review of valuation studies in wetlands from elsewhere in Africa and other parts of the world. Such studies show a very wide range

of values, ranging from lower end values in the $275-$350/ha/year range to over $3,300 in some cases where water regulation is a particularly important issue.

Given the characteristics of the area & types of functions that will be typical of the wetlands, this study has assumed a value of $600 for permanent wetlands and $400 for the seasonally inundated areas; in large part reflecting the flood control and water retention functions of these areas that ensure that the Tabora region, which has highly seasonal rainfall, does not experience damaging floods or extensive droughts in areas that would otherwise be highly vulnerable to these problems. The valuation figures chosen are in the lower to middle range of such values from international studies and are considered to be appropriate for the study area.

Other areas also have functions in this field, with the woodlands area in particular generating over $220 million of value. The thickets, shrublands and grasslands have lower valuations but still generate some ecosystem services values for water regulation functions. This is an important function of woodlands worldwide and again is instrumental in ensuring the productive capacities of different land cover areas is maintained throughout the year. The total figure for these areas is based on an estimated figure of $50/ha/year for woodlands and $30/ha/year for the other areas. These estimates can be considered to be conservative as they are at the lower end of international estimates from a range of studies for comparable environments that are available on this topic. This in part reflects the characteristics of the area, which does not have major hydropower or irrigation schemes downstream and does not feed major urban areas; watershed functions that will generate substantially higher values than those assumed for the Tabora Region.

No valuation has been given for cultivated areas, as these areas (which are mostly characterized by rain-fed farming) will be net consumers of water rather than playing an important role in water regulation. Overall, water regulation functions can be recognized as an extremely important set of ecosystem services values that land resources in the region generate. These are vital to economic functioning, human safety and the integrity of ecosystems across the region. These values are typically not included in many economic accounting systems but they are of great economic significance nonetheless.

4.2.3 Biodiversity Values

The essence of biodiversity value is that it embodies the value of information and insurance. The existing diversity is a result of evolutionary processes over several billion years (Pearce, 2001). Hence the existing diversity embodies a stock of information, and, because the evolutionary process has occurred in the context of many different environmental conditions, the diversity of living things also embodies characteristics that make them resilient to further natural changes. In this study, since the biodiversity value of the study area is unavailable, Benefit Transfer Approach was adopted. Although Benefit Transfer Approach is cheaper and faster, it has been a subject of considerable controversy in economics literature, because of it being used inappropriately. Benefit Transfer can provide valid and reliable estimates under certain conditions. These

include the requirement for the commodity or service being valued to be very similar at the site where the original estimates were made and the site where they are being applied.; and the populations affected should also have very similar characteristics. Various authors have used this method such as Barbier *et al*, (1994); Rauser & Small (1998); Pearce *et al*.(2002) among others for biodiversity valuation. Ruitenbeck (1988) reported an evergreen forest in Cameroon to be worth US$ 4 per hectare in terms of its biodiversity in terms of medicinal plants for bioprospecting and pharmaceutical industries. Table 3 shows that contribution of biodiversity to the value of Tabora land is the highest and this is due the fact that much of the land in the region is designated as a conserved area. It has a value of US 65 **billion** very close to the contribution of carbon stock which is 44 **billion** (Table 3).

Below is a summary of economic information on biodiversity for different land cover types in Tabora Region. The figure provided in brackets is the monetary value in terms of US$ $ha^{-1}year^{-1}$. The information is summarized in Table 3.

4.2.3.1 Woodland

This land cover type occupies an area of 4,407,791 ha, and covers the largest part of Tabora Region. The following were included in the biodiversity value of the woodland: Timber (US$ 3,877); NTFPs (US$ 50); Poles (US$ 5,169.4); Charcoal (US$ 1,407.2); Pharmaceuticals/Bio-prospecting (US$ 2.1); Flood Protection (US$ 3.0); Climate Damage (Amelioration) Avoidance (US$ 62.0) and Erosion Control (US$ 185.0).

4.2.3.2 Plantation Forest

This land cover type has an area of 633 ha and it is the smallest land cover type in Tabora Region. Under this cover type the following items were valuated to include Timber; Poles; Firewood; NTFPs; Erosion Control and Climate Damage Avoidance. The corresponding monetary values are the same as for the woodland cover type.

4.2.3.3 Bushland

Has a coverage of 432,968 ha, and the items valuated in this land cover type included Timber; NTFPs; Poles; Firewood; Charcoal and Pharmaceuticals/Bio-prospecting.

4.2.3.4 Cultivated Land

This land cover type has an area of 892,502 ha and only two items were valuated to include Pollinators (US$ 14 $ha^{-1}year^{-1}$) and Pharmaceuticals/Bio-prospecting (US$ 2.1 $ha^{-1}year^{-1}$))

4.2.3.5 Grassland

This land cover type has an area of 201,518 hectares. Under this land cover for valuation, the following were considered: Gas Regulation (CO_2)(US$ 200 $ha^{-1}year^{-1)}$; NO US$ 200 $ha^{-1}year^{-1}$); Climate Regulation (US$ 0.11$ha^{-1}year^{-1}$); Erosion Control (US$ 26.7 $ha^{-1}year^{-1}$) and Soil Formation (US$ 1.2 $ha^{-1}year^{-1}$). Note that the monetary value of erosion control in grassland is much higher than that of woodland and forest as the

data is from two different sources. The former is from Piementel *et al*. (1995) and the latter is by Costanza *et al*. (2001).

4.2.3.6 Permanent Swamp

This covers an area of 146,798 hectares. The following economic valuation was done to include: Food Production (US$ 12.0 $ha^{-1}year^{-1}$); Drinking Water (US$ 100.0 $ha^{-1}year^{-1}$); Gas regulation (US$ 265.0 $ha^{-1}year^{-1}$); Flood Control (US$ 3,341 $ha^{-1}year^{-1}$); Nutrient Cycling/Waste Treatment (US$ 1,700 $ha^{-1}year^{-1}$) and Withies (US$ 2,584.7 $ha^{-1}year^{-1}$).

4.2.3.7 Seasonally Inundated Swamp

This is a large land cover type with a coverage of 1,445,539 hectares. Economic valuation was done for: Food Production; Firewood; Drinking Water; Flood Control; Waste Treatment/Nutrient Cycling and Withies.

4.2.3.8 Thicket

This land cover type has 94,434 hectares. Among the items valuated included NTFPs *e.g*. ropes etc; Poles; Firewood; Charcoal; Pharmaceuticals/Bio-prospecting and erosion Control. The economic value of the different land cover types is summarized in Table 1.

4.2.4 Cultural & Aesthetic Values

The assessment of cultural and aesthetic values is extremely difficult and somewhat arbitrary. These values are important and can have direct economic significance: for example where the characteristics of a landscape and the wildlife it contains make it attractive for tourism or where cultural traditions and relations to land are important in the ways that land resources are managed and exploited, with this often of particular importance where, as is the case in Tabora Region, the use of common property resources are central to people's livelihoods.

The data in Table 3 does contain a valuation for these functions of just over **$91 million** for the whole region: not a large figure when compared to other ecosystem services functions in the region but nevertheless an indication that these values are important to local communities and the regional economy and should be taken into account when decisions on the governance and management of land resources are taken. This figure reflects a valuation of **$12/ha/yr** across the range of land cover types. This is probably a conservative estimate, as would be greater in some areas if tourism developed to be significant. The figure is derived from studies of areas with similar environmental characteristics in South Africa in particular and as such may be contestable when applied to this region of Tanzania given the difference in the economic conditions of the two countries but it is still considered to be a reasonable estimate for the study area.

4.2.5 Carbon Sequestration

The ability of land resources, both vegetation and soils, to absorb and store atmospheric carbon is increasingly recognized as a vital ecosystem service given the growing global consensus on the issue of climate change. This is in particular increasingly an issue of policy and even economic significance given the expansion in

carbon trading markets and the emerging popularity of REDD (Reducing Emissions from Deforestation and forest Degradation) as a means for mitigating carbon emissions. A recent paper on REDD in Tanzania stated that "the general consensus is that REDD is potentially a low cost and a win-win option for climate change mitigation"[2]. This is true globally and there are increasingly significant funds available to stimulate REDD programmes.

The miombo ecosystems of Tanzania have a high potential for carbon sequestration and mitigating CO_2 emissions. However, reliable estimates for their potential are few and inadequate. The study carried out in the southern highlands of Tanzania to quantify the carbon pools in Miombo woodlands established that a mean above ground carbon density of the Miombo ecosystem as 19.2 tonnes per hectare (Munishi et al., 2010). Various tree dimensions were used in the assessments. Of the total carbon, 40% and 60% being contributed by above-ground biomass, below-ground biomass and the soil respectively. The Below-Ground Biomass (BGB) or the contribution of roots to the carbon stock was estimated to be 15-20% of the above-ground biomass (Nabuurs *et al*., 2003), and in this case, 15% for Miombo woodlands (Mujumba & Lyaruu, 2010).

Different species contributed differently to carbon stocks in these ecosystems with *Brachystegia spiciformis* and *Julbernardia globiflora* contributing the most. The estimated carbon stocks in this ecosystem is within the range observed in dry forests elsewhere despite the differences in stages of regeneration and variations in the extensity of exploitation pressure(Munishi et al., 2010). Munishi et al. (2010) reported also that under proper management there is a tremendous capacity for carbon storage in the Miombo woodlands to mitigate carbon emissions.

Miombo species tend to invest much in roots. Mature Miombo woodlands contain a significant amount of carbon in the above ground parts (40%) and in soil (60%), depending on climate. Thus conversion of these woodlands to short-duration crop agriculture would release large amounts of carbon dioxide to the atmosphere (IPCC 1996). Using the findings by Munishi et al. (2010) as baseline, and the fact that about 60% of the carbon stock is stored in the below ground parts (roots), then the amount of carbon sequestered in the roots would be about 28.8 tonnes per hectare. Thus the total carbon stock (above and below ground) in the miombo ecosystem would be 48 tonnes per hectare. The carbon sequestration potential can be even higher if we consider the amount of Carbon stored in the undergrowth of herbaceous layer, litter and other organic debris and tree samplings including the smaller (DBH below 6cm) which are relatively numerous in some parts of the forests but not usually used in the forest biomass assessment (Munishi et al., 2010). Assessment of carbon stock in these materials as well as below ground stock can add to the carbon storage potential of this ecosystem. On the other hand, if Miombo woodlands were managed to maximise carbon storage, a substantial quantity of carbon could be sequestered in biomass, soils and woodland products. Thus further studies are important to evaluate the root and soil

[2] Mwakalobo, A. et al (2011) **REDD and Sustainable Development – Perspectives from Tanzania** REDD Working Papers, IIED, London, page 1.

carbon in these ecosystems in determining the full potential of these ecosystems to act as a carbon sink.

The assessment of the value of the carbon sequestration of different land areas differs from that of other ecosystem services values in that it is best measured as a total stock – the value of the total amount of carbon stored in the vegetation and soils – rather than as an annual "income" or flow of ecosystem services values over time that are available to local people and economic processes. As such, the data in table 1 on the carbon sequestration valuation is a **total stock value**. The figure that has been calculated, at nearly **$44 billion**, is a high value and represents a significant proportion of the total value of the land resources of the Tabora Region. The method used to calculate this value is based on the review of available literature on this issue, using estimates from similar ecosystems across the region and the world to estimate the total carbon stock of the different land cover types. It must be noted that this includes both the carbon in the vegetation, which is widely recognized, and the carbon stored in the soils, which is an issue often neglected but one of particular significance in drier environments such as the study region. The method used to calculate the total figure and figures for each land cover type are shown in Table 4.

Table 4. Estimated Carbon Stocks and Values of Tabora Region

Major Land Cover Types	Area (Ha)	Tonnes of Carbon (above ground)	Tonnes of Carbon (below ground)	Tonnes of Soil Carbon	Total carbon storage in the ecosystem	Value of Carbon (USD)
Bushland	432,968	14,720,912	2,208,137	25,393,574	42,322,623	719,484,583
Cultivated land	892,502	0	0	66,937,650	66,937,650	1,137,940,050
Grassland	201, 518	6,851,612	1,027,742	11,819,031	19,698,385	334,872,545
Permanent Swamp	146,798	2,935,960	440,394	5,064,531	8,440,885	143,494,045
Seasonally Inundated Swamp	1,445,539	28,910,780	4,336,617	49,871,096	83,118,493	1,413,014,373
Plantation Forest	633	12,027	1804	20,747	34,578	587,818
Thicket	94,434	3,210,756	481,613	5,538,554	9,230,923	156,925,683
Woodland	4,407,791	83,748,029	12,562,204	144,465,350	240,775,583	40,931,184,903
Other, Water, Urban	20,932					
GRAND TOTAL	**7,643,115**	**140,390,076**	**21,058,511**	**307,110,533**	**468,559,120**	**44,837,504,000**

The **woodland area** accounts for three-quarters of these values, reflecting both that this is the largest land cover area and also that carbon stocks tend to be higher in woodlands and forests than in other land cover types because of the greater volume of biomass material per hectare they contain. The characteristics of the woodlands of the region, and especially the dominant miombo woodlands, with regard to carbon storage differentiate them from many forests in more humid tropical areas in that the majority of the carbon is not stored in the above-ground biomass but is rather stored below ground in plant materials and the soil[3]. This is an area where further research is needed, but the analysis presented here can still be considered to be robust and a reflection of the most recent research available in this field. For the analysis here, a Figure of 19 tonnes carbon per hectare (tc/ha) has been used for above ground storage in woodlands and 101 tc/ha for below ground storage, indicating the importance of the below ground carbon in these environments.

Indeed, the below ground carbon is estimated to comprise over 80% of the carbon storage across all land cover types in the region. Even the cultivated lands contain significant carbon stores in their soils, whereas the nature of the land management means that there is little or no above ground storage in these areas. Similarly, it is estimated that 60% of the carbon in grasslands, bushlands and thickets is stored in subterranean biomass and soils, whilst the figure for wetlands is 66%. The consequence is that carbon sequestration is an ecosystem service that is of high value across all land cover types in the study area. At $13 billion, these total values are something that needs much higher attention in policy terms. The significance of this cannot be over-emphasized as even where above-ground vegetation is substantially cleared the majority of stored carbon will be retained to a greater or lesser extent.

Table 5. Practices in Managing Forest Resource at Community level.

Type of management	**Village**		
	Maboha	***Itebulanda***	***Mbola***
1. Planting of trees	Yes, but to a limited extent	*Yes , it is common*	Yes, but to a limited extent
2. Cutting down undesired (competing) trees	No, not at all	No, not at all	No, not at all
3. Protecting certain desired (patches of) trees in the forest to promote the natural regeneration of these species	Yes, but to a limited extent. (including *Mninga, Mikulungu* and *Mkola, all* timber trees)	*Yes , it is common* (included are *Mninga, Mkola* and *Mpilipili, all* timber trees)	Yes, but to a limited extent (included are *Mninga* and *Mkola* (timber trees), and *Mtonga* (a wild fruit tree)

[3] The following references were particularly valuable in this analysis: Bond, I et al (2010) **REDD+ in dryland forests: issues and prospects for pro-poor REDD in the miombo woodlands of southern Africa** IIED, London**.** Williams M., C.M. Ryan, R.M. Rees, E. Sambane, J. Fernando and J Grace (2008) '**Carbon sequestration and bio-diversity of re-growing miombo woodlands in Mozambique**'***, Journal of Forest Ecology and*** *Management* 54: 145–55. Elsevier, Amsterdam.

4. Protecting areas of forest for particular environmental services, like water catchment	No, not at all	Yes, but to a limited extent	Yes, but to a limited extent
5. Establishing clear use rights for a limited number of people to particular forest products (e.g., honey trees)	No, not at all	No, not at all	Yes, but to a limited extent. This is essentially done with support from "Total Land Care", an NGO that promotes the use of signposts in protected areas to prevent livestock keepers from trespassing. This is mainly done on private/individual lands that are protected.
6. Fire breakers	No, not at all	No, not at all	Yes, but to a limited extent, and often done on individual basis
7. Management of invasive alien species (IAS)	No, not at all	*Striga spp* (a weed locally known as *makasimba*); and reeds	No, not at all

1) Codes: 0=no, not at all; 1=yes, but only to a limited extent; 2=yes, they are common.

It was noted that there is a tree planting campaign in each tobacco growing area or village. The seedlings are being offered together with a bag of fertilizer. Unfortunately, during the discussion it was noted that villagers' responses to this campaign were not encouraging, i.e. they don't carry or plant the seedlings. The main reason they gave for not planting the seedlings was that it is costly to transport and manage the seedlings. However, we encourage the initiatives of Millennium project or similar to that to other villages for proper land resource management. Other initiatives related to tobacco processing are the use of improved barns that are considered to be more energy efficient, using less fuelwood.

5.0 Conclusions and Policy Implications

The analysis presented in the above paragraphs illustrates the best calculations available of the total economic value of the land resources of Tabora Region, though data limitations have meant that some important ecosystem services such as biodiversity have not been valued. The results of the analysis are startling, with the three ecosystem service categories of provisioning services, water regulation and cultural and aesthetic values together generating an annual flow of ecosystem services worth close to $2.5 billion and the total stock value of the carbon sequestrated in the biomass and soils of the different land cover categories being estimated to be worth close to $13 billion. These data are estimates, but they are based on the best information available and in many cases conservative figures have been used to calculate them.

If anything and remembering biodiversity values are not included, the figures would in all probability be higher rather than lower than those presented here if more comprehensive data to make the estimates of value were available. Research to fill such data gaps is needed, and is of particular importance in relation to dryland areas

such as Tabora as the amount of studies globally on such areas is limited. Some topics, such as soil carbon and biodiversity valuation, are in particular need of attention but overall the knowledge base on the value of land resources and ecosystem services in such areas needs significant strengthening in order to make a more complete analysis with lower degrees of uncertainty in the analysis.

The analysis also emphasizes the importance and value of land resources in the livelihoods of the vast majority of people living in Tabora. Livelihood patterns in rural areas are typically a complex mix of activities that take advantage of a range of ecosystem services from different types of land resources. Most people farm but farm sizes are usually small and productivity is low (with ample opportunities for improvement). Rural people could not survive if they were not also grazing livestock in forests, grasslands or other areas and if they were not gathering a wide range of products (fuelwood, foodstuffs, building materials, medicinal plants and many other things) from woodlands or similar areas. It is the ability to combine different opportunities from different land resource areas that defines the livelihoods of people in the study area. This needs to be more fully recognized in poverty reduction and economic development policies, and in particular strategies to reduce poverty and support livelihoods development through improved land management systems for all land cover categories that are utilized by local people needs to be devised.

These strategies to support livelihoods through improved access to and management of land resources also need to take into account the other essential ecosystem services functions that the land resources provide. Water management, carbon sequestration, biodiversity values and others are, as we have seen, important and extremely valuable aspects of the total economic value of land resources in Tabora. These are not generally translated into directly tradable goods or services but this does not mean that they are not of economic significance and they should be reflected in the overall policy frameworks for sustainable development in the Tabora Region and elsewhere in Tanzania. The type of valuation reported in this paper, whatever its limitations, does provide an important piece of evidence to this policy discourse, reminding all parties in language that they can understand and appreciate, economic value, that sustainable land management should be a high priority and actions to limit or reverse land degradation are a necessity for the health and welfare of Tanzania's people and national economy as much as the sustainability of its environment.

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Annex 1: Most common indicators used for different ecosystem services

ECOSYSTEM SERVICE		INDICATOR
PROVISIONING	Food	Agricultural production (crop yield)
		Grassland livestock production
		Forage production
	Timber	Timber harvest
	Fuel	Fuel wood energy
	Fresh water	Surface runoff
		Stream discharge
		Water surplus (rainfall-evapotranspiration)
REGULATING	Climate regulation	Carbon sequestration
		Carbon storage
	Water flow/flood regulation	Contribution of groundwater to base flow
		Vegetation cover in watershed, water storage in wetlands
	Natural hazard regulation	Avalanche protection
	Disease regulation	(no indicator yet)
	Water purification/quality	Water N or P content
		Water sediment loading
	Air quality regulation	N emissions
	Erosion control	Soil erosion potential and vegetation cover
		Soil erosion
	Waste treatment	Removal of nutrients, pathogens metals and sediments
SUPPORTING	Nutrient cycling	Soil fertility
	Soil formation	Soil organic matter accumulation
		Sedimentation
	Primary production	NPP
	Pollination	Distance to natural habitat/proportion of natural habitat
	Pest control	Distance to natural habitat/proportion of natural habitat
CULTURAL	Aesthetic	House prices
	Recreational	Site visitation rate
	Spiritual	(Not specified, value transfer from individual studies)
	Educational	(No indicator yet)

Source: IIEP *et al.* (2009)

Annex 2: Detailed methods and data requirements for ecosystem service valuation

Ecosystem service	Technique	Detailed method	Data requirements
Products & raw materials	Market prices	Forests – timber: amount harvested X price	Regional production /consumption statistics (m^3/year for major timber species), price of major timber species, area under major timber species
		Forests – NTFP: amount harvested X price	By region: (i) what are the major NTFPs, (ii) for major NTFPs, how much is being harvested each year, what is the price
		Forests – TCM: amount harvested X price	By region: (i) what are the major TCMs, (ii) for major TCMs, how much is being harvested each year, what is the price
		Grasslands – pasture: value of livestock production supported by grasslands	By region: number of livestock, livestock production/income figures, areas of grasslands, sustainable and actual stocking rates
		Wetlands – fish, other aquatic animals: amount harvested X price	By region: (i) what are the major species, (ii) for major species, how much is being harvested each year, what is the price, what are the sustainable offtake rates
		Wetlands – food plants, reeds, etc.: amount harvested X price	By region: (i) what are the major species, (ii) for major species, how much is being harvested each year, what is the price, what are the sustainable offtake rates
Carbon sequestration	Market price	Forests, Grasslands, Wetlands: Rate of CO_2e sequestered/ha/yr X market price of carbon.	Sequestration rates will need to be found for each major sub-category of ecosystem, and compared to sequestration rates under agriculture.
	Replacement cost	Forests, Grasslands, Wetlands: Carbon released as a result of land use change X market price of carbon, and thus cost avoided.	Total carbon locked up per hectare will need to be found for each major sub-category of ecosystem, and compared to sequestration rates under agriculture.
	Damage costs avoided	Forests, Grasslands, Wetlands: Damages resulting from floods in terms of loss of property, infrastructure, crops, etc. – only for flood-prone areas which are fed by rivers which flow through or originate in ecosystems, also need to apply a conversion factor for ecosystem role in flood mitigation	Base on sites where data exists on flood damage costs and extrapolate to all flood-prone areas which are fed by rivers which flow through or originate in ecosystems: area that is affected by floods, per hectare damage costs arising from floods, annual likelihood of floods, index for ecosystem role in flood prevention

	Type of Values		Assessment Methods
	Direct values	Outputs that can be	**- Market Prices**

USE VALUES	**(*Goods and products):***	consumed or processed directly, such as timber, fodder, fuel, non-timber forest products, meat, medicines, wild foods, etc	**- Surrogate market & stated preference approaches**
			• Travel Costs
			• Contingent Valuation
			  ○ The amount people would pay/accept under the theoretical condition that biodiversity could be bought and sold. People's stated willingness to pay
			• Conjoint Analysis
			  ○ Obtains information on preferences between various alternatives of environmental goods and services, at different price or cost.
			• Choice Experiment
			  ○ Present a series of alternative resource or use options, each of which are defined by various attributes including price.

	Indirect values (*Ecosystem services)*	Ecological services, such as flood control, regulation of water flows and supplies, nutrient retention, climate regulation, etc.	**- Productivity & cost-based approaches**
			• Effect on Production
			• Replacement Costs
			• Cost of providing substitute services
			• Damage cost avoided
			  ○ The costs avoided from the destruction of ecosystem (A minimum estimate of money saved). E.g. Value for watershed protection and hydropower generation. Failure to invest in watershed management as a component of dam maintenance could incur NPC of over $2million in terms of power revenues foregone
			• The costs of mitigating ecosystem degradation
			  ○ The costs of mitigating or averting the effects of the loss of an environmental good or service (A minimum estimate of money saved). For example, value of watershed catchment protection for urban and rural water supplies (Infrastructure to mitigate erosion, seasonal low water supplies and flooding)

	Option values	Premium placed on maintaining resources and landscapes for future possible direct and indirect uses, some of which may not be known now.	**- Surrogate market & stated preference approaches** • Travel Costs • Contingent Valuation