Connecting poverty & ecosystem services

A series of seven country scoping studies

Focus on Tanzania

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Background

Ecosystems provide more than the resources needed for material welfare and livelihoods. In addition to supporting all life and regulating natural systems, they specifically provide health and cultural benefits to people. Moreover, their loss is a significant barrier to the achievement of the Millennium Development Goals related to reduction of poverty, hunger and disease. The Millennium Ecosystem Assessment (MA),[1] released in 2005, reported, though, that 15 of the 23 ecosystem services assessed were being degraded or used unsustainably.

In light of these findings, this report sets out to provide a preliminary review of ecosystem services in Tanzania and the corresponding constituents and determinants of well-being related to the availability of these services. This paper is one of seven scoping studies prepared by the International Institute for Sustainable Development for the United Nations Environment Programme. Other countries examined in this series are Kenya, Mali, Mauritania, Mozambique, Rwanda and Uganda. All of the papers are available online at http://www.iisd.org/economics/

The objective of the series is not to provide a detailed assessment of the poverty-environment linkages, but to identify the regions within the countries where critical ecosystem services for human well-being are stressed, signalling the need for immediate attention. This information is expected to inform and guide the selection of potential areas where a more detailed local-scale integrated assessment of the links between ecosystem services and human well-being can be carried out.

These reports do not cover previous policy interventions, as the local-scale integrated assessment would gather such information and report on the impacts these polices have had in the past. Lessons learned can then be used together with new knowledge gathered on the links between ecosystem services and human well-being to design more finely-tuned intervention strategies that would seek to promote the reduction of poverty and improve well-being while protecting and enhancing vital ecosystem services.

1 The Millennium Ecosystem Assessment was a four-year study requested by the United Nations Secretary General in 2001 to provide an overview of the state of the global ecosystems and the consequences of ecosystem changes on human well-being.

Executive Summary

1. Tanzanians are experiencing pervasive water scarcity and inability to earn an adequate livelihood, as both are threatened in all mainland regions. These two constituents are mutually reinforcing as over 80 per cent of the population achieves livelihood through subsistence farming.
2. Regions experiencing deterioration in food and fibre provision, also face serious problems in meeting adequate nourishment levels.
3. Morogoro Region stands out as it is experiencing stress in all four ecosystem services and well-being constituents, which suggests that it should be a priority region for development efforts.
4. Biodiversity is now under threat in several regions, a loss that is particularly distressing, as Tanzania has had a long tradition of conserving biodiversity.
5. The main problem confronting most regions is the management of water with most of the population facing difficulty accessing water. The lack of appropriate technology for managing water, coupled with the increasing loss of forests and vegetative cover has increased the rate of runoff and precipitation capture. This is further compounded by population growth of five per cent annually.
6. Declining food yields are caused by decreasing soil fertility and by farmers working the land more intensively, compounded with a lack of expertise in using fertilizers and decreasing supply of natural fertilizers from cattle.

Ecosystem services and constituents of well-being: degrees of threat by region

	Maintenance of biodiversity	Food production	Water supply	Energy resources	Adequately nourished	Clean water	Energy for warmth and cooking	Earn livelihood
Arusha	X	X	X	O	X	X	X	X
Dar es Salaam	O	X	X	O	O	X	X	X
Dodoma	X	X	X	O	X	X	X	X
Iringa	X	X	X	O	O	X	O	X
Kagera	X	O	X	X	O	X	X	X
Kigoma	X	X	X	O	O	X	O	X
Kilimanjaro	O	X	X	O	X	X	X	X
Lindi	X	X	O	X	X	X	X	X
Manyara	X	O	O	O	X	X	O	X
Mara	O	X	X	O	X	X	O	X
Mbeya	O	X	X	O	O	X	O	X
Morogoro	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Mtwara	O	X	O	O	O	X	O	X
Mwanza	O	X	X	O	O	X	O	X
Pemba North	N/A	N/A	N/A	N/A	O	X	O	X

Ecosystem services and constituents of well-being: degrees of threat by region *(continued)*

	Maintenance of biodiversity	Food production	Water supply	Energy resources	Adequately nourished	Clean water	Energy for warmth and cooking	Earn livelihood
Pemba South	N/A	N/A	N/A	N/A	O	X	O	X
Pwani	X	X	O	X	X	X	X	X
Rukwa	O	X	X	O	O	X	O	X
Ruvuma	N/A	N/A	N/A	N/A	O	X	O	X
Shinyanga	O	X	O	O	X	X	X	X
Singida	O	X	X	O	X	X	X	X
Tabora	O	X	O	O	X	X	O	X
Tanga	X	X	X	O	X	X	O	X

- X indicates an ecosystem service or well-being constituent under threat in the particular region.
- O indicates that an ecosystem services or well-being constituent is not under threat.
- **Bold** highlights those areas of immediate priority.

Ecosystem services

The literature review of Tanzania's ecosystem services revealed four critically stressed ecosystem services: maintenance of biodiversity; food and fibre provision; water supply, purification and regulation; and fuel provision.

Maintenance of biodiversity

Tanzania boasts a vast array of biodiversity and some of Africa's richest and most diverse flora is found in Tanzania. Tanzania's protected areas equal the percentages of land under protection in North America and Europe. However, despite the levels of protection, biodiversity is steadily declining with population growth and movement leading to deforestation, encroachment and habitat change. Invasive species, such as the water hyacinth, have also had negative impacts on biodiversity.

Food and fibre provision

In Tanzania, food crops account for 85 per cent of land under agricultural cultivation. Tanzania is one of African's largest cattle and milk producers with meat and manure used for food and fertilizer. The fisheries are also a vital source of income and nourishment, however, they are currently not suffering. The population increase in Tanzania has degraded the agro-ecosystem such that its ability to support productive agriculture and large livestock numbers has declined.

Water supply regulation and purification

Agriculture is the primary use for water and is responsible for 89 per cent of water withdrawals and, as a result of inconsistent supply, only 45 per cent of the population has access to safe water. Water supply and quality are decreasing due to human population growth as well as a loss of vegetation cover. Inappropriate farming practices and deforestation have caused soil erosion and reduced water regulation services leading to increased flooding. In addition, unregulated water extraction, human migration and haphazard development threaten access to clean water.

Fuel provision

The main sources of energy in Tanzania are fuel wood and charcoal from both natural and plantation forests, which constitutes a vital provisioning service offered by ecosystems. Deforestation and subsequent wood shortages are caused by land conversion to agriculture, livestock grazing and wood resources. When fuel wood is not available, households rely on cow dung and crop residue. Compounding biological issues, there is a lack of clear policies and regulations guiding competition for land resources thus encour-

aging free access to land and poor tenure arrangements. Gender-balanced forest management, inadequate technological innovation and inefficient wood-based industry are also contributing factors to poor forest management.

Human well-being

Human well-being is multi-dimensional with many constituents and is closely linked with the state of ecosystem services. This report focuses on those well-being determinants which are affected by the state of ecosystems services which include: ability to be adequately nourished; ability to access adequate clean water; ability to have energy and to keep warm; and ability to earn a livelihood.

Ability to be adequately nourished

The main factor underpinning poor nourishment is the inability to grow enough food. Food supply is characterized by a corresponding decline in ecosystem services with decreasing agricultural production due to inadequate distribution and quantity of rainfall, desertification and a lack of economic entitlements. The high prices of staple foods are also a contributing factor in the ability to purchase food. Commonly, people with little access to livestock or alternative means of generating income have turned to illegal bush meat hunting which can either provide food or income.

Ability to have adequate and clean drinking water

Fifty per cent of Tanzanians are without sustainable access to an improved water source and increases in urban populations have stressed the infrastructure servicing urban areas. Availability and level of use of water is influenced by several other factors such as cost, wealth of the household, number of people per household, etc. Water availability is also influenced by water supply and purification services such as seasonality of rainfall, increased sediment loads in rivers due to deforestation and soil erosion, pollution and overgrazing.

Ability to have energy to keep warm and cook

Currently, fuel wood is being consumed faster than it is being replaced and Tanzania faces enormous energy problems; people have to go longer distances to obtain firewood; woodfuel is becoming scarcer requiring the use of low quality biomass fuels; and the need to buy wood, which was formerly a free commodity. The ability of this ecosystem service to continue to provide Tanzanians with energy is highly compromised.

Ability to earn a livelihood

Tanzania's economic entitlements are very low and 42 per cent of the population lives below the poverty line. While most agriculture in Tanzania is for subsistence, there are some cash crops earning export income. Given the high rates of poverty and lack of improvement in garnering better livelihoods for most Tanzanians, all regions of Tanzania are experiencing an inability to earn an adequate livelihood.

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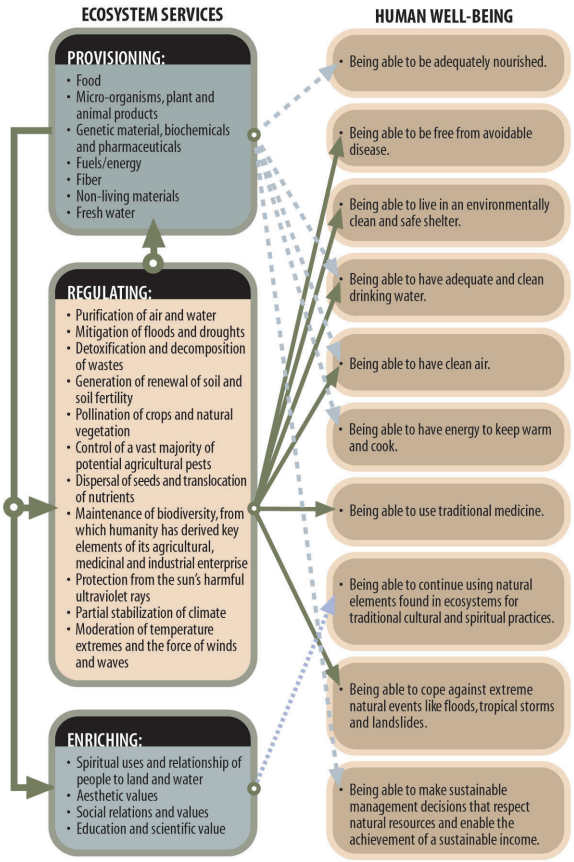
Introduction

The primary objective of this report is to identify regions within Tanzania where critical ecosystem services for human well-being are stressed. These regions were identified through an extensive literature review and research which spatially connected ecosystem services and human well-being within Tanzania. The framework of ecosystem services and human well-being categories developed by the Millennium Ecosystem Assessment, illustrated in Figure 1, was used (Alcamo *et al.* 2003; Duraiappah 2002; Daily 1997). This review does not intend to be an exhaustive description of all ecosystem services. Instead, it identifies those ecosystem services in Tanzania found to be deteriorating or in danger of deteriorating in the near future—in other words, ecosystem services that are stressed. Furthermore, when considering human well-being, we broaden our attention beyond the traditional constituent of material wealth (economic growth and livelihood) to also include other constituents: the ability to be adequately nourished; the ability to have access to freshwater; and the ability to have access to energy to keep warm and to cook, among others (Duraiappah 2004). Like ecosystem services, we only report on human well-being constituents directly or indirectly related to ecosystem services and, hence, this report should not be viewed as a comprehensive survey of all constituents of human well-being.

While not exhaustive, this overview does point out what ecosystem services and constituents of human well-being are most in need of attention and where they are located at the regional level. By taking this unique approach and using a finer spatial lens, areas where well-being and ecosystems are stressed emerge and clarify difficult trade-offs being made at the local level.

This report is organized into four sections with the first briefly describing the people and landscape of Tanzania, thus providing a backdrop for the rest of the overview. Section 2 scopes out the main ecological services stressed and pinpoints their locations. Section 3 then discusses the related constituents of well-being that are increasingly being threatened by these deteriorating ecosystem services, and, as with ecosystem services, locates them. The concluding section co-locates those regions where ecosystem services are stressed with those where the constituents of human well-being are threatened and then briefly outlines the more outstanding trade-offs being made.

Figure 1. The links among ecosystem services and human well-being



(Source: Duraiappah 2002)

1. Tanzania in Brief

The borders of Tanzania define an amazingly diverse country. In addition to being located in Africa's Great Lakes Region, it is home to the Serengeti Plains where "some of the largest concentrations of wildlife in the world can be found (White 1983 in Aryeetey-Attoh 2003, 39). Tanzania also contains mountains, such as well-known Mount Kilimanjaro, and ocean coastlines along the Indian Ocean, and includes the exotic, off-shore islands of Zanzibar and Pemba. The people of Tanzania reflect their diverse landscape; there are more than 100 tribal groups, mainly of Bantu origin, Masaii in the northeast and people of Arab ancestry in Zanzibar and Pemba.

Map 1: Tanzania Regions[2] (Tanzania 2002b)

Tanzania: Area and Regions

Total area: 942,784 sq km
Land area: 881,289 sq km (includes the islands of Mafia, Pemba and Zanzibar)
Water area: 61,495 sq km

Administrative regions: Tanzania consists of 26 regions: Arusha, Dar es Salaam, Dodoma, Iringa, Kagera, Kigoma, Kilimanjaro, Lindi, Manyara, Mara, Mbeya, Morogoro, Mtwara, Mwanza, Pemba North, Pemba South, Pwani, Rukwa, Ruvuma, Shinyanga, Singida, Tabora, Tanga, Zanzibar Central/South, Zanzibar North, Zanzibar Urban/West.

1.1 Physical geography and natural environment

Tanzania is a relatively large, coastal country at the south-eastern edge of Sub-Saharan Africa. Tropical rainforest and moist forest systems follow the lowland coast and the western border from where the land rises in rolling plains to a central plateau. "To the west, this plateau drops sharply to Lake Tanganyika," while volcanic mountains and steep hills rise up from it in the north-east (FAO Forestry Department). The mountain line bifurcates with one branch going southward into Malawi and the other curving northwestward to the Ufipa Highlands, and here "a series of hills is contiguous to Rwanda and Burundi" (FAO Forestry Department). There are four distinct ecosystem types: namely, forest, covering 27 per cent the of total land area; cropland/natural vegetation mosaic covering 39 per cent; shrub lands, savannah and grasslands covering 27 per cent; and wetlands or water bodies covering the remaining seven per cent (World Resources Institute 2003b).

Climate

Average precipitation is 937 mm per year, but about 50 per cent of the country receives less than 750 mm with total rainfall declining north to south (FAO 1995). The central plateau receives 200–600 mm and is classified as semi-arid, while the coastal zone and southern and northern highlands receive abundant rainfall, between 1,400 and 2,000 mm annually (ODA in Quinn 2003, 111; Encyclopedia.com 2005). The dry season lasts four to six months, but is shorter and less severe in the northeast than in the south (Sawatt and Mollel 2000).

Topography

Tanzania consists of coastal plains in the east, highlands in the north and south, and a central plateau which is divided into two branches by the Great Rift Valley (Encyclopedia.com 2005). Highland mountains cover 100,000 sq km of the mainland and reach a maximum elevation of 5,894 m at Mount Kilimanjaro (PLDPT 1984 in Sawatt and Mollel 2000; United States Central Intelligence Agency

2 Regional Census Data and District Maps available by clicking on Map Region. http://www.tanzania.go.tz/census/regions.htm

2005). In contrast, the central plateau consists of sloping plains and undulating hills with an average elevation of 1,070–1,370 m (Kerario 1995, 4; Encyclopedia.com 2005).

Hydrology

There are five major drainage basins: Indian Ocean drainage system, comprised of Lake Nyasa and the rivers Pangani, Wami, Ruvu, Rufiji and Ruvuma; the Lake Eyasi basin in the North; the Lake Rukwa basin in the southwest; Malagarasi basin flowing into Lake Tanganyika; and the Lake Victoria basin which drains via the Nile River (Kerario 1995, 4). The western branch of the Great Rift Valley contains Lake Tanganyika, while the eastern branch runs through central Tanzania, merging with the western branch just north of Lake Nyasa (Encyclopedia.com 2005). Tanzania's water systems cover 61,500 sq km and include about 50 lakes (Vanden Bossche and Bernacsek 1990 in Chenje and Johnson 1996, 100).

Arable land

Tanzania has 43 million ha of land suitable for agriculture and of this 7,710,304 ha were cultivated in 2003–2004 (Majule 2004; World Resources Institute 2003; Tanzania Ministry of Agriculture and Food Security 2003).

1.2 Demographics

Since independence in 1967, the population of Tanzania has grown from 12,313,469 to 34,569,232 in 2002 (Tanzania 2002c). Kigoma Region, at 4.8 per cent, is experiencing the highest average annual population growth rate, while Lindi is experiencing the least at 1.4 per cent. In addition, Tanzania has long been host to thousands of refugees from neighbouring countries; currently more than 400,000 live in 13 camps, many situated near the Burundi border, and are almost entirely dependent on foreign aid (United States Committee for Refugees 2005).

1.3 Economy: Observable constraints

During the period 1996–1999, Tanzania recorded an average real growth rate of 4.9 per cent per annum and per capita real growth of around 1.2 per cent (Tanzania 2000). This trend continued in 2000, with real GDP rising to 5.1 per cent, but per capita real growth remaining relatively consistent at 1.1 per cent from 2000 to 2002 (OECD 2002, 281; Norwegian UN Association *et al.* 2002). Overall GDP growth was hindered by the agricultural sector which reported a lower rate of growth—three per cent—compared to 4.6 per cent in 1999, mainly due to a decline in cash crop production (OECD 2002, 281). This was offset, however, by a pickup in industrial production and substantial increase in output of minerals, led by gold. Oil and gas exploration and development also contributed to this growth (United States Central Intelligence Agency 2005).

Box 1. Tanzania: demographics (2004)

Population:

Total:	34,443,603
0–14 years:	44.2%
15–64 years:	53.2%
65 years and over (2004 est.):	2.6%

Life expectancy at birth:

Average:	44.39 years
Male:	43.20 years
Female (2004 est.):	45.61 years

Fertility rate (2000–2005):

Number of births per woman:	5.1

Annual population growth rate (1975–2002):

Per cent per year:	3.0%

Population density (per sq km), 2002:

Average:	39
Most dense region: Dar es Salaam (DSM) Region	1,793
Least dense region: Lindi:	12

Ethnic groups:
Mainland – native African 99% (of which 95% are Bantu consisting of more than 130 tribes), other 1% (consisting of Asian, European, and Arab); Zanzibar - Arab, native African, mixed Arab and native African

Languages:
Kiswahili and English

(Tanzania 2002b; United Nations Development Programme 2004; United States Central Intelligence Agency 2005)

Box 2. Development and macro-economic indicators

Natural resources:
Soils, water, minerals, fisheries, wildlife and forests, hydropower, tin, phosphates, iron ore, coal, diamonds, gemstones, gold, natural gas, nickel

Allocation of GDP by sector (2000):

Agriculture (commercial and subsistence production):	45%
Industry:	16%
Services:	39%

Industry is traditionally comprised of the processing of agricultural products and light consumer goods

Trade account (2000) in US dollars:
Imports: $2,094 million:
Petroleum, consumer goods, machinery and transport equipment, used clothing, chemicals, pharmaceuticals
Food aid constitutes 10.6% of total imports
Exports: $2,325 million:
Coffee, cotton, tea, sisal, diamonds, cashew nuts, tobacco, flowers, seaweed, fish, and cloves
Agriculture generates 85% of exports earnings

Main employment sector:
Agriculture employs 84.4% of the population, most of which is subsistence agriculture with pastoralism and agro-pastoralism being the main livelihoods in semi-arid areas

GDP (constant 1995 US dollars), 2000:	$6,419 million
Per capita income (per year):	$250

Income distribution:

Gini coefficient (100% is perfect inequity):	38
Per cent of total income earned by richest 20% of population:	45.5%
Per cent of total income earned by poorest 20% of population:	6.8%
Adult literacy rate (per cent ages 15 and above), 2002:	77.1
Human Development Index (HDI) value, 2002:	0.407
Human Development Index (HDI) rank (out of 177):	162

(United Nations Development Programme 2004; United Nations Environment Programme 2004; United States Central Intelligence Agency 2005; World Resources Institute 2003a; United States Department of State 2005; Tanzania 2003; AFRODAD 2003)

Tanzania is one of the poorest countries in the world. Having not made sufficient progress towards its Millennium Development Goals, it was identified as one of the "top priority" countries in this year's Human Development Report (Amani, Kessy and Macha 2004, 155). Its total external debt is US$7,705 million, and debt service is 16.6 per cent of export earnings (World Resources Institute 2003a). Recent banking reforms, however, have helped increase private sector growth and investment with the net inflow of foreign direct investment increasing to US$193 million in 2000 and international tourism receipts earning US$313 million from 1995 to 1997 (World Resources Institute 2003a). Continued donor assistance and solid macro-economic policies supported real GDP growth of more than 5.2 per cent in 2004 (United States Central Intelligence Agency 2005).

2. State of Ecosystem Services

The literature review identified maintenance of biodiversity, food and fibre provision, water supply, purification and regulation, and energy resources as the four critical ecosystem services deteriorating in Tanzania. We discuss each in detail below, outline some of the main factors influencing their deterioration and, where possible, identify the regions in which they are declining. We start with biodiversity loss, as it is maintained by ecosystems and unpins ecosystem functioning and hence availability of ecosystem services overall.

2.1 Biodiversity

Only very recently, theoretical and empirical work has identified linkages between changes in biodiversity and the way ecosystems function (Schulze and Mooney 1993; Loreau, Naeem and Inchausti 2002). The common perception of the value of biodiversity is limited to specific uses of a limited number of specific species for human use. However, there is increasing theoretical and empirical evidence of a much more complex relationship between biodiversity—defined as the variability among living organisms; this includes diversity within species, between species and of ecosystems—and ecosystem services. Species perform numerous services for ecosystems; for example, in many ecosystems, there are a variety of species that fix nitrogen in the soil. The importance of the composition of the species is determined by how much a loss in the ecosystem service is experienced when one or more of the species is lost. The lower the impact of a loss in species to ecosystem functions, the higher is the level of redundancy in the system.

Status of biodiversity

Tanzania boasts a vast array of biodiversity, with much of it being endemic and is home to numerous species including 20 primates; 34 antelope; 290 reptile; 40 amphibian, and many fish (Tanzania.c). In addition, Africa's richest and most diverse flora is found in Tanzania in the Zambezian regional centre of endemism (Tanzania.c). Overall, there are six biological hotspots that have value as centres of high species diversity and high levels of endemism, namely the Eastern Arc old block mountain forests, the coastal forests, the great lakes for Cichlid fishes, the ecosystems of the alkaline Rift Valley lakes, and the grassland savannahs for large mammals (Tanzania Vice President's Office 2001, 12). In addition, wetlands cover about 10 per cent of the country's total surface and are home to a multitude of aquatic flora and fauna (Tanzania Vice President's Office 2001, 17).

Currently, 13 million ha, or 11.5 per cent, of Tanzanian lands are under protection, an amount that is twice the average percentage under protection for sub-Saharan Africa, and approximately equal to the percentage protected in Europe, North America and Australia (IUCN 1994 in Mwamfupe 1998). In addition to the 12 National Parks, there are 28 game reserves, 38 game controlled areas and the Ngorongoro Conservation Area, which together cover 38.8 per cent of the country's total area (Tanzania Vice President's Office 2001, 5). Tanzania's protected areas include: Ngorongoro Conservation Area (in Arusha Region); Serengeti National Park (in Mara, Arusha and Shinyanga regions); Maswa Game Reserve (on the southwestern border of Serengeti National Park (Shinyanga Region); Ruaha National Park (in Mbeya and Ingringa regions); Selous Game Reserve (in the Coastal, Morogoro, Lindi, Mtwara and Ruvuma regions); and Pugu and Kazimzumbwi Forest Reserves (in Pwani Region) (Mwamfupe 1998). Tanzania protects 3,233 sq km of mangrove forests, housing 10 mangrove species and seven seagrass species and has 57 genera of scleractina coral, nine of which are protected (World Resources Institute 2004).

However, in spite of the large area of protected areas, biodiversity is steadily declining. Tanzania has 43 plant and 123 animal species that are critically endangered or endangered, including 19 threatened freshwater fish species (IUCN 2004; World Resources Institute 2003c). Even though the Eastern Arc Mountains forest is a biodiversity hotspot, by 1998 as much as 77 per cent of the original cover had been converted to other uses (Newmark 1998). In addition, the miombo woodlands which cover about 90 per cent of forest reserves are being degraded at a rate of 300,000–400,000 ha per year (Barrow, Gichohi and Infield 2000, 11).

Factors influencing biodiversity loss

Population growth and movement are having a devastating impact on biodiversity. Population growth has increased the demand for fuel wood and other forest products and land for cultivation and grazing, leading to deforestation and encroachment into protected and steep sloped areas (Mwamfupe 1998). This situation will undoubtedly be exacerbated by future population growth; Tanzania's population is expected to double from 30 to 60 million by the year 2020 (Mwamfupe 1998). In the short term, though, human migration is having dramatic, short-term impacts on the environment and on biodiversity through habitat change (Mwamfupe 1998). Pastoral groups with expertise in the sustainable use of grazing lands have migrated from the north and central regions to regions where they have adopted crop cultivation practices but with little ecological knowledge on how to manage the soil for the cultivation of crops (Mwamfupe 1998). In addition, as livestock and human populations grow, demand for cultivatable land grows causing further pressure on biodiversity (Ngailo *et al*. 2001). Some changes have led to the intensification of agriculture and introduction of new mono-cropping species[3] but, in general, the overexploitation of plants and animals has reduced the agro-ecosystem and natural forest diversity (Ngailo *et al*. 2001).

Another source of concern is the increasing negative impact of invasive species caused by growing human population. One major invasive, non-native species affecting Tanzania is the water hyacinth, a floating aquatic weed that clogs waterways and depletes fish biodiversity (Pest CABweb 1997). In Tanzania's portion of Lake Victoria, water hyacinth covers 2,000 ha[4] and it also occurs in the Kagera, Sigi and Pangani rivers, in streams and ponds around Dar-es-Salaam, and near Lake Victoria (Mailu 2001). Invasive fish species are also increasing in number as people have been supplementing fish fauna in Lake Tanganyika (IUCN 2004).

Park managers also find that poaching and illegal hunting of endangered species for bush meat and for sport is a perennial problem. Ultimately, the lack of public understanding of the importance of wildlife and of baseline data, inadequate rural user rights, and limited human and financial resources plague wildlife (Tanzania.c.).

Regions most affected by biodiversity loss

In Tanzania, the most egregious biodiversity loss occurs in areas with high biodiversity, rapid population growth/migration and drastic land cover change, particularly on steep slopes. In many cases, areas of high biodiversity are close to areas of rapid human population growth. For example, the Eastern Arc mountain system (Morogoro, Dodoma, Iringa, Manyara, Arusha regions) and the Zanzibar-Inhambane coastal region of coral reefs and mangrove forests are the most genetically rich areas in the country (United Nations Environment Programme 2004; Tanzania 2002a). Within this area, Urban West, Dar es Salaam, Arusha and Manyara regions have the highest population growth rates in the country (4.5 per cent; 4.3 per cent; 4.0 per cent; and 3.8 per cent respectively) second only to Kigoma (Tanzanian 2002a). Clearly, Pugu and Kazimzumbwi Forest Reserves, Pwani's tiny, highly diverse coastal forests in the peri-urban zone of Dar es Salaam face immense risk (Mwamfupe 1998).

Furthermore, land cover change on sloped land quickly alters soil erosion, nutrient balances and, thus, biodiversity. On Mount Meru, Arusha National Park, near Ng'iresi, Olgilai, Moshono and Kiserian villages, slopes can be as steep as 30–50 per cent. Here, forest cover was once thick but, currently, most plant and animal species are extinct and only a few isolated patches of the forest cover remain (Ngailo *et al*. 2001).

In the north, human migration is a problem for biodiversity. Refugees that flooded the Kagera Region poached wildlife heavily in the surrounding game reserves (Tanzania 2003a). Due to in-migration, the Maasai population surrounding Ngorongoro Conservation Area (Arusha Region) has been growing at two to three per cent per year (Mwamfupe 1998).

- Arusha: Deforestation; population growth
- Dodoma: Deforestation
- Iringa: Deforestation
- Kagera: Refugees cutting trees for fuel wood and construction

3 In recent years, however, the introduction of non-traditional cash crops such as flowers, cabbage and round potatoes, and planting trees for soil conservation has helped to maintain agro-diversity (Ngailo *et al.* 2001).

4 However, increased weed stunting and disintegration of existing mats indicates that the water hyacinth is suffering stress, in part from the weevils released into the lake (Mailu 2001).

- Kigoma: Refugees cutting trees for fuel wood and construction
- Lindi: Deforestation
- Manyara: Deforestation
- Morogoro: Deforestation
- Pwani: Pugu and Kazimzumbwe Forest Reserves due to population growth; mangrove and wetland conversion, especially Rufiji River forests, woodland and wetlands
- Tanga: Forest reserve encroachment and deforestation

(Tanzania Vice President's Office 2001)

2.2 Food and fibre provision

Ecosystems provide the medium for growing the food on which humans and domesticated animals are dependent; this includes the vast range of food products derived from plants, animals and microbes. If the cultivation of plants for food and livestock is to succeed, then natural factors such as fertile soils, adequate soil moisture, suitable climatic conditions and a rich source of plant and animal species are necessary. Deficiencies in some of these elements or attributes can be augmented by technology through the use of fertilizers, irrigation, high-yield seeds and domesticated animals over the short term and for longer periods if managed sustainably.

State of food and fibre provision services

In Tanzania, agriculture is dominated by small-holder farmers "cultivating an average farm size of between 0.9 hectares and 3.0 hectares each" (Tanzania 2003). Food crops account for 85 per cent of land under agricultural cultivation with the main subsistence crops being maize covering 24–26 per cent of cultivated land, beans covering roughly 18 per cent, while finger millet and numerous cash crops each cover about eight to nine per cent (Tanzania 2003; Ngailo *et al.* 2001).

Tanzanians obtain much of their protein through beans, supplemented by fish, livestock and bush meat, with fish and fish products accounting for about 30 per cent of national animal protein intake (Tanzania.c). Fisheries are a vital source of income as well, as 21 per cent of Tanzania's population lives within 200 km of the coast with approximately 80,000 people being permanently employed by fishing (World Resources Institute 2004; Tanzania.c). Annual exports in fish and fish products are up a staggering 14,098 per cent since 1980, and currently worth US$58,069,000 (World Resources Institute 2004). The main lakes in Tanzania (lakes Tanganyika, Nyasa, Victoria, Eyasi and Rukwa) also support fisheries with Lake Tanganyika alone directly employing 100,000 (IUCN 2004). In addition to agriculture, aquaculture is a quickly growing source of food and export earnings. Aquaculture production (including freshwater fish) increased from 35 metric tons in 1987 to 250 metric tons 10 years later (World Resources Institute 2004).

Tanzania is one of Africa's largest cattle and milk producers with meat and manure from cattle and goats being used for food and fertilizer (OECD 2002; Ngailo *et al.* 2001). Pastoralists raise around 16 million cattle and 15 million sheep and goats on an estimated 600,000 sq km of grazing land (FAO 1999). Livestock density is highest in Mwanza and Mara regions at over 75–100, and >100 animals per sq km respectively (FAO Forestry Department). Commercial ranching accounts for only two per cent of Tanzania's total cattle herd, however, livestock production accounts for approximately 30 per cent of the agricultural GDP (Tanzania.a). In the Mara and Shinyanga regions, bush meat is an important source of protein and potential income for those living along the western boundary of Serengeti National Park. Here, villagers rely primarily on meat from animals that they did not husband: 92.3 per cent purchase livestock meat, 82 per cent purchase bush meat, and over a third consume bush meat caught by a family member (Loibooki *et al.* 2001).

Despite the variety of food sources available, several natural factors constrain food production. In many areas of the country, rainfall is not effective for agriculture, even in places that receive high average rainfall because its reliability is low (PLDPT 1984 in Sawatt and Mollel 2000). Erratic rainfall and cold stress risk limit agricultural production in Arusha, Shinyanga and Kilimanjaro regions in the north, Dodoma Region and Iringa, Mbeya and Rukwa regions in the south and west (FAO Forestry Department). As well, in the semi-arid northern and central regions, evapo-transpiration is very high, soil moisture is hard to maintain and there is a high risk of desertification (PLDPT 1984 in Sawatt and Mollel 2000). In these areas, drought is a major limitation to livestock production, especially in Arusha, Dodoma, Singida, Shinyanga, Tabora and Mwanza regions

(Sawatt and Mollel 2000). In addition, low soil suitability affects scattered areas in Lindi, Ruvuma, Morogoro, Iringa and Mbeya regions in the south, Rukwa and Kigoma regions in the Lake Tangunyika basin, as well as Arusha Region in the north (FAO Forestry Department).

Fibre production (cash crops)

A wide range of commercial and cash crops are also grown, providing an important source of income for local farmers and accounting for the majority of export earnings (FAO 1999; United States Department of State 2005). Coffee alone earns 17 per cent of Tanzania's foreign exchange and covers approximately 13.6 per cent of cultivated area (Ngailo *et al.* 2001). Farmers also grow cash crops such as tea, cotton, cashew nuts, sisal, cloves and pyrethrum (insecticide made from chrysanthemums) to generate income (United States Department of State 2005).

Factors influencing food and fibre provision

Since the late 1970s, average per capita food production in Tanzania has declined by 32 per cent compared to 11 per cent for Sub-Saharan Africa. In 1999, maize production was 228,000 tonnes, roughly 60 per cent lower than the previous year and 40 per cent below the long-term average (FAO 1999). According to a 1999 government report, an estimated 61 per cent of the country faces desertification and localized land degradation (Tanzania Vice President's Office 1999, 3). Factors contributing to soil loss and desertification are: inappropriate cultivation techniques, growing human population, growing energy requirements, over stocking and insecure land tenure (Tanzania 2002).

Population increase in Tanzania has degraded the agroecosystem such that its capacity to support productive agriculture and large livestock numbers has declined (Ngailo *et al.* 2001). In densely populated highland regions, the average farm size has decreased and generally fallow periods have become shorter, not allowing sufficient time for regeneration and recovery of soil fertility (Tanzania 2002). Currently, the majority of farmers in high altitudes, such as those in Arumeru District, Arusha Region, cannot support sufficient numbers of cattle and goats, and are usually limited to two per household (Ngailo *et al.* 2001). In general, livestock production has not kept pace with population increase, and the average Tanzanian only drinks half the quantity of milk drunk by his or her Kenyan neighbour (Agriculturist 2003).

Another confounding factor is the prevalence of tsetse fly infestation in 60 per cent of the grazing land, thus concentrating livestock in the semi-arid centre and north of the country in Arusha, Shinyanga and Mwanza regions (PLDPT 1984 in Sawatt and Mollel 2000; Tanzania 2002; Agriculturist 2003). The result has been overstocking, such as in Shinyanga and Arusha regions where livestock stocking excess is over 200 per cent (Tanzania 2002).

Desertification is also having a major impact in the country, adversely affecting the quality of grazing lands and livestock which in turn limits agricultural output and compounds other environmental problems (PLDPT 1984 in Sawatt and Mollel 2000). One example is increased soil acidification due to the excessive use of nitrogenous fertilizers particularly in maize fields in southern coastal Tanzania (Lindi, Mtwara), as well as in Songea District of Iringa Region (Majule 2004).

In contrast to agriculture and livestock, fishery production as a whole is currently not suffering. Fishing pressure varies within the country and although fishing is managed sustainably in some areas, there is a long-term trend of over-fishing overall (Jiddawi and Ohman 2002). In Lake Tanganyika, damaging fishing practices are starting to deplete fish stocks, adversely affecting food supply in Rukwa and Kigoma regions (IUCN 2004a). In addition, overfishing is a problem along the main coast of the Dar es Salaam Region (Pronker 2002).

Regions most affected by deterioration in food and fibre provision

The trend since 1994–1995 to the present shows an annual 0.8 per cent fall "in the ability of farmers to meet food and non-food requirements in Tanzania," though a shorter trend line over the past four years shows gains (Tanzania Ministry of Agriculture and Food Security 2004; Tanzania 2003b, 13). The "self-sufficiency ratio" measured as a percentage, is used to calculate the ability of food produced to meet demand for food and other food-related requirements in a particular area[5] (Tanzania Minstry of Agriculture and Food Security 2004). By using this measure,

5 This is based on crop production.

regional-level trends dating from 2000–2001 show that Arusha, Dar es Salaam, Dodoma, Kilimanjaro, Manyara, Pwani (Coast) Shinyanga, Singida and Tabora are not able to produce enough food three or more of the five years analyzed (Tanzania Ministry of Agriculture and Food Security 2004). Furthermore, Arusha, Dar es Salaam, Kilimanjaro, Manyara, Pwani (Coast) and Shinyanga are food deficient for 2004–2005.

- Arusha: High risk of desertification and severe localized land degradation; over-stocking of cattle
- Dar es Salaam: Fish catch deteriorating
- Dodoma: High risk of desertification and suffer severe localized land degradation
- Iringa: Low soil suitability and soil acidification
- Kigoma: Fish catch deteriorating
- Kilimanjaro: Soil degradation
- Linidi: Soil degradation
- Mara: Over-stocking of cattle; soil degradation
- Mbeya: Low soil suitability and soil acidification
- Morogoro: Low soil suitability and soil acidification
- Mtwari: Soil acidification
- Mwanza: High risk of desertification and suffer severe localized land degradation; over-stocking of cattle
- Pwani: Soil degradation
- Rukwa: Fish catch deteriorating
- Shinyanga: High risk of desertification and suffer severe localized land degradation; over-stocking of cattle
- Singida: High risk of desertification and suffer severe localized land degradation
- Tabora: High risk of desertification and suffer severe localized land degradation
- Tanga: Soil degradation

(Tanzania Vice President's Office 1999, 3; FAO Land and Water Development Division 2004; FAO Forestry Department; Tanzania 2002).

2.3 Water supply, purification and regulation

Ecosystems play a key role in the provisioning of clean freshwater and regulating the flow of water. The effectiveness of ecosystems to provide these services is determined largely by the quality of the country's watersheds (see Box 3).

Box 3. What is a watershed?

A watershed is the area of land that catches rain and snow (if applicable) and drains or seeps these into a marsh, stream, river, lake or groundwater. Their primary function is to capture, store and safely release water. This function is indicated by The Internal Renewable Water Resource (IRWR). For example, as snow melts on mountain peaks in the spring, much of the water soaks into the ground, replenishing soil moisture and groundwater. This water will be a source of flow to local streams and rivers during dry seasons. Healthy soils and vegetation in the watershed are essential to proper watershed functioning (Donaldson and Swanson 2001).

Tanzania's main source of water is precipitation and this ranges significantly among regions. Tanzania shares three major lakes (Victoria, Tanganyika and Malawi) as well as the Rovuma River along the border with Mozambique (FAO 1995). On average the country receives 82 cu km per year internal renewable water resource from precipitation (World Resources Institute 2003c). This provides 2,227 cu m freshwater per capita, which is about half the per capita average for Sub-Saharan Africa, but still sufficient to cover current withdrawals (World Resources Institute 2003c). Due to uneven distribution of rainfall, a prolonged dry season and arid/semi-arid conditions, surface water is limited most of the year (Tanzania 2002). Worthy of note are the ecosystem services provided by two catchment forest reserves in the Uluguru Mountains in Morogoro and Pwani regions; they are the source of water for Dar es Salaam (World Rainforest Movement 2002). Groundwater recharge occurs mainly through rainfall and potential use varies widely. Groundwater development has mainly focused on shallow wells for domestic purposes, but some localities have high potential for irrigation (Majule 2004).

State of freshwater supply, purification and regulation service

Agriculture is the primary use for water and is responsible for 89 per cent of water withdrawals, followed by industry at two per cent and domestic use at nine per cent (World Resources Institute 2003c). The total withdrawal rate is 1.2 cu km of freshwater per year, or 39 cu m per capita, which is only 1.6 per cent of actual renewable resources (World Resources Institute 2003c). As a result of inconsistent supply, however, approximately 45 per cent of the population has access to safe water and Tanzania is expected to fall into water stress by 2025 and scarcity by 2050 (Tanzania Research and Analysis Working Group 2002, 75; FAO 1995; United Nations 1994; Stockholm Environment Institute 1997).

Not only is water supply a growing concern, but so is water quality. Tanzania produces roughly 10,000,000 cu m of wastewater annually and pollution from domestic and industrial waste is increasing (FAO 1995; IUCN 2004a). Lake Tangunyika supports 10 million Tanzanians in its basin, but recently, water intake for Kigoma City, Kigoma revealed substantial amounts of hydrogen-sulfide producing bacteria, likely resulting from domestic wastewater (O'Reilly and Muller 2002). One stream supplying water to Dar es Salaam was found to be contaminated with mercury and lead coming mostly from small industrial plants discharging untreated waste directly into the river (Dickinson 2003).

Factors influencing water use, regulation and purification

Water supply and quality are decreasing due to human population growth as well as loss of vegetation cover. Inappropriate farming practices and deforestation have caused soil erosion and reduced water regulation services leading to increased flooding after rains and reduced water flow between rains, particularly in Morogoro Region (Paavola 2004). Although Tanzania protects 1.6 out of 13 million ha of forest under water catchment management strategies, particularly on steep slopes, rapid clearing of forest cover in some protected areas has affected soil retention and water flow regulation (Mwamfupe 1998; Tanzania.c; FAO Forestry Department 2003). In Serengeti National Park, water quality has also decreased in the lower regions, possibly due to wetland degradation and destruction fringing the Seronera River and this has impacts for downstream human populations in the Lake Victoria River basin in the Mara and Mwanza regions (Gereta, Mwangomo and Wolanski 2004).

In addition, unregulated water extraction, human migration and haphazard development threaten access to clean water (UNEP.net 2002; IUCN 2004). Uncontrolled and unplanned development is responsible for domestic and industrial waste in many freshwater bodies. For instance, breweries, abattoirs, paint industry and battery manufacturers north of Tanzania, as well as many smaller cities around Lake Tanganyika including Burundi's capital, Bujumbura, are releasing untreated water directly into the lake (IUCN 2004). Rapid population growth and uncontrolled industrial development in Arusha and Moshi cities have lead to domestic, agricultural and industrial wastewater pollution in the Pangani River catchment, which supplies water to Arusha, Kilimanjaro and Tanga regions (Mwanuzi 2000). In another instance, approximately 500 tonnes of obsolete fertilizer stored in rural areas is slowly leaking into the water table (Dickinson 2003). The influx of 600,000 refugees from Burundi and Rwanda for over a decade has created a water supply and sanitation problem in Kagera Region and large volumes of sediment are being deposited into Lake Tanganyika from surrounding deforestation and tillage practices (IUCN 2004; Tanzania 2003a).

Regions most affected by deterioration in freshwater supply, purification and regulation

- Arusha: Water shortages and drought; water quality
- Dar es Salaam: Water quality
- Dodoma: Water shortages and drought
- Iringa: Water shortages and drought
- Kagera: Water shortages and drought; water quality
- Kigoma: Water shortages and drought regions; water quality
- Kilimanjaro: Water shortages and drought; water quality; siltation
- Mara: Water quality
- Mbeya: Water shortages and drought
- Morogoro: Flooding

- Mwanza: Water quality
- Rukwa: Water quality
- Singida: Water shortages and drought
- Tanga: Flooding; water quality[6]

(Majule 2004; Paavola 2004)

2.4 Fuel provision

The main sources of energy in Tanzania are fuel wood and charcoal from both natural and plantation forests, which together account for 93 per cent of total energy consumption and constitute a vital provisioning service offered by ecosystems (Tanzania). Of this, wood, a source of energy on which more than 90 per cent of the population depends, accounts for 90 per cent of total energy consumption, (Tanzania 2002). Fuel wood is harvested from the approximately 38.8 million ha of forests and woodlands, and 97 per cent of all wood taken from these forests is used for fuel (Tanzania Vice President's Office 2001, 5; World Resources Institute 2003b; Tanzania.c).

State of fuel as ecosystem service

Despite the naturally abundant forests, deforestation is a serious threat. Only 29 per cent of the current forest resource is protected and FAO estimates that the current rate of deforestation of 130,000 to 500,000 ha per annum, is having a devastating impact on biodiversity and ecosystem functioning (FAO 2003). Overall, the country's forest area has declined from 44,300,000 ha, or 50 per cent of total land area, in 1938 to 33,096,000 ha, or 43 per cent of total land area, in 1987. However, more wood is now being harvested from plantations; for example, in 1999, a total of 127,202.11 cu m were harvested from plantations and 26,269.78 cu m from natural forests (FAO 2003).

In some cases, when fuel wood is not available, households rely on cow dung and crop residue for energy (Tanzania National Forest Program 2004). The supply of these biological resources depends on the number of livestock and availability of crop residue after harvest. In addition, the search for scarce fuel wood takes women away from important activities like family care and tending to agriculture. In urban areas, fuel wood and charcoal are very expensive, thus compelling some families to reduce the number of meals per day (Tanzania National Forest Program 2004).

Factors influencing the decline in biological fuel services

Deforestation and subsequent wood shortages are caused by land conversion to agriculture, livestock grazing and wood resources (including fuel[7]). Both agricultural expansion and free-range pastoralism have resulted in vegetation loss throughout the country (FAO 2003). As well, forests are cleared for uncontrolled development, industry and mining (Tanzania 2002; FAO 2003). Unfortunately, two thirds of Tanzania's forest is natural woodlands on public lands with inadequate management and there is a lack of clear policies and regulations guiding competition for land resources, thus encouraging free access to land and poor tenure arrangements (FAO 2003; Tanzania.c).

Several other factors contribute to poor forest management and forest depletion including a significant lack of gender-balanced forest management involving women, inadequate technological innovation, inefficient wood-based industry and poor infrastructure (Tanzania 2004; FAO 2003). Insufficient forestry extension services and a lack of baseline data for conservation, management and utilization of available forest resources also hamper effective resource use (Tanzania.c; FAO 2003).

Commercial fuel wood extraction for charcoal production is no less destructive; it requires large volumes of wood and causes high tree stock depletion, i.e., deforestation (Monela *et al.* 1999). Charcoal is often hauled for more than 300 km, but little data exist on the actual extent of deforestation due to urban charcoal use (FAO 1999a; Monela *et al.* 1999).

Regions most affected by deterioration in fuel services

The miombo woodlands, the primary source of fuel wood and charcoal, constitute roughly 90 per cent of Tanzania's 33.35 million ha of forest and woodlands and are being degraded at a rate of 300,000–400,000 ha per year (Barrow 2000, 11; Monela *et al.* 1999). They occupy the central plateau in the north (Morogoro Region), and in the southeast (Lindi Region) (FAO, Forest Department). Charcoal production in this region, specifically in Kitulangalo, Morogoro, Mbwewe and Pwani, is responsible for 75 per cent of woodland degradation (Monela *et al.*

6 Map of Precipitation, FAO http://www.fao.org/countryprofiles/Maps/TZA/06/pp/index.html

7 Domestic fuel consumption accounts for 94 per cent of the total 38,193,000 cu m of roundwood harvested annually (WRI 2004).

1999). In Kagera Region, refugee settlement and fuel wood demand has caused "colossal" deforestation (Tanzania Government 2003). In general, the southern regions have the most intact and closed forest.[8] As such, Lindi Region, one of the most heavily forested regions in Tanzania with much intact miombo woodland, is under increasing threat of new expansion and development (Mpingo Conservation Project).

- Kagera: Refugees
- Lindi: Miombo woodland degradation
- Morogoro: Miombo woodland degradation
- Pwani: Miombo woodland degradation

2.5 Summary of ecosystem services stressed

The survey of ecosystem services stressed focused on the 21 regions that are on the Tanzanian mainland, as little information was found on the islands of Zanzibar and Pemba. Of the 21 mainland regions, 20 were found to have ecosystem services that are deteriorating with Ruvuma being the only exception. This does not mean, however, that ecosystem services in Ruvuma are not under threat, but rather this result should be cautiously interpreted as a data gap.

Almost all of the remaining regions (18 out of 20) were experiencing declining food production, while 14 were also water stressed. Biodiversity was found to be threatened in 10. One region, namely Morogoro, was found to have all four ecosystem services stressed, pointing to the need for further investigation. Arusha, Kagera, Kigoma, Lindi, Pwani and Tanga regions each were experiencing deterioration in three of the four ecosystem services, and several of these same regions are facing the double challenges of deteriorating food and fibre provision and water supply, regulation and quality services.

Table 1. Summary: Ecosystem services stressed by region

Region	Ecosystem services stressed
Arusha	Biodiversity Food production Water supply, purification and regulation
Dar es Salaam	Food production Water supply, purification and regulation
Dodoma	Biodiversity Food production Water supply, purification and regulation
Iringa	Biodiversity Food production Water supply, purification and regulation
Kagera	Biodiversity Water supply, purification and regulation Fuel (energy)
Kigoma	Biodiversity Food production Water supply, purification and regulation
Kilimanjaro	Food production Water supply, purification and regulation
Lindi	Biodiversity Food production Fuel (energy)
Manyara	Biodiversity
Mara	Food production Water supply, purification and regulation
Mbeya	Food production Water supply, purification and regulation
Morogoro	Biodiversity Food production Water supply, purification and regulation Fuel (energy)
Mtwari	Food production
Mwanza	Food production Water supply, purification and regulation
Pwani	Biodiversity Food production Fuel (energy)
Rukwa	Food production Water supply, purification and regulation
Shinyanga	Food production
Singida	Food production Water supply, purification and regulation
Tabora	Food production
Tanga	Biodiversity Food production Water supply, purification and regulation

8 Map of Forest Cover, FAO http://www.fao.org/forestry/foris/webview/forestry2/index.jsp?siteId=2181&sitetreeId=5966&langId=1&geoId=19

3. State of Human Well-being

Human well-being is multi-dimensional with many constituents and determinants closely determined by the state of ecosystem services (Duraiappah 2004). However, not all constituents may be under serious threat in a country and not all of these constituents are directly dependent on the state of ecosystem services. Therefore, as emphasized in the beginning, only constituents and/or determinants of well-being directly affected by the state of ecosystem services are covered in this report. Our preliminary review identified the following critical constituents which appear to be under serious threat among many social groups within Tanzania.

3.1 Ability to be adequately nourished

The ability to be adequately nourished is dependent on two factors; the ability to grow food and the ability to buy food. While the supply of food is critical, economic entitlements that individuals are able to secure, such as income from non-farm labor, are also important (Sen 1990). There are several measures of the ability to be adequately nourished including that of food (in)security as well as incidence of malnutrition, among others.

State of the ability to be adequately nourished

As subsistence crop production dominates the agricultural economy, as well as the Tanzanian economy as a whole, the main factor underpinning poor nourishment is inability to grow enough food. Food supply is characterized by declining agricultural production due to inadequate distribution and quantity of rainfall, desertification and lack of economic entitlements. As a result of poor rainfall, planting areas and yield have fallen sharply and maize production is significantly below average (FAO 1999). In 2001, 43 per cent of the population was undernourished, up from 35 per cent in 1990 and the average per capita consumption is merely 1,940 kcal per day, compared to the world average of 2,808 kcal (United Nations Development Programme 2004; Amani, Kessy and Macha 2004, 162). Malnourishment from inadequate nutrient (vitamins and minerals) intake is widespread, particularly among young infants and adolescent girls and women (Amani, Kessy and Macha 2004, 162).

The ability to be adequately nourished not only depends on food supply but also on the economic entitlements to buy food. High staple food prices are a problem. Reflecting low supply, maize prices continued to rise in several markets, aggravating the food-security situation of a large number of people (FAO Economic and Social Department 2004). A price comparison of the staple commodities maize and sorghum in Dodoma, Shinyanga, Mwanza, Mara and Singida regions shows that prices have increased since 2000 (Famine Early Warning System 2004). Inappropriate pricing and unreliable cash flow to farmers continue to aggravate the agricultural sector (United States Department of State 2005). Although trends in maize price vary across markets, their absolute level is a concern for poor households in urban areas and isolated rural areas where poor crop production forces farmers to depend on markets rather than their own food production (Famine Early Warning System 2004). About 80 per cent of food vulnerable persons are in regions where maize prices approach or exceed the maize price level of TShs 15,000–18,000 per 100 kg (Famine Early Warning System 2004).

Commonly, people with little access to livestock or alternative means of generating income have turned to illegal bush meat hunting which can either provide food or income (Loibooki *et al.* 2002). For those in urban areas, urban agriculture is flourishing as people look for ways to cope with rising costs of living (Tanzania 2003). In Tanzanian towns and cities, producers of vegetables, milk, meat and eggs are selling to private households, as well as schools, hospitals, hotels, bars, cafes and restaurants (Tanzania 2003).

Regions most affected

- Arusha: Crops failed due to drought
- Dodoma: Food shortages
- Kilimanjaro: Crops failed due to drought; maize loss due to recent drought was 100 per cent

- Lindi: Food shortages
- Mara: Crops failed due to drought
- Morogoro: Food shortages
- Manyara: Food shortages
- Mwanza: Crops failed due to drought
- Pwani: Food shortages
- Shinyanga: Food shortages; crops failed due to drought
- Singida: Food shortages
- Tabora: Crops failed due to drought
- Tanga: Crops failed due to drought

(FAO Economic and Social Department. 2004; Famine Early Warning System 2004)

3.2 Ability to have adequate and clean drinking water

Access to adequate and clean drinking water is essential for a healthy life. The minimum standard set by the United Nations as required by an individual to satisfy human needs is 1,000 cu m per year (Biggs *et al*. 2004, 13). Clean water can be provided in a number of ways. Filtration plants using modern technology provide clean water, but watersheds in pristine condition can offer the same quality of water. In a well known example, the city of New York was able to provide clean water to its habitants by restoring and preserving the Catskill watershed which basically captures, stores, purifies and releases water. The cost saved by preserving the watershed vis-à-vis building a modern water filtration plant was in the region of about $4 billion (Daily and Ellison 2002; Duraiappah 2005).

State of ability to have adequate and clean drinking water

Coverage rates for water that were collected in 2000 show that 80 per cent of urban and 42 per cent of rural Tanzanians have access to water (Mujwahuzi 2002, 8). Overall, 50 per cent of the population is without sustainable access to improved water sources and barely 65 per cent of urban and 43 per cent of rural residents have access to potable water within 400 metres (United Nations Development Programme 2004; Tanzania 2002). Despite efforts by the government to provide people with easy access to water sources there has been a decrease in per capita water use during the past 30 years; for example, the mean per capita water use in piped households has declined from 141.8 litres per day in 1966 to 80.2 litres per day in the mid-nineties (Mujwahuzi 2002, 45). This does not hold, however, for mainly rural unpiped households who saw an increase in mean per capita water use from 13.5 litres to 18.6 litres per day (Mujwahuzi 2002, 45).

Factors influencing the ability to have adequate and clean drinking water

Mujwahuzi (2002, 45) listed several factors influencing the decrease in mean per capita water use for piped households as being: "the ageing of the water supply infrastructure; lack of adequate maintenance; and increased pressure on the existing inadequate infrastructure due to increased industrial and domestic demand." Much of this is attributed to increases in urban populations. Despite an overall increase in water use in rural areas, the much lower daily per capita water use here can largely be attributed to drought conditions, as water has to be carried for longer distances and there are long waiting times at the water point to fill water containers resulting in less water being carried home (Mujwahuzi 2002, 48).

Availability and level of use of water is influenced by several other factors such as cost, relative wealth of the family, the number of people in the household (amount of water for each member decreases as the number of people increases), the proportion of children and, in the case of piped households, the number of hours of service that make water available, and in the cases of the unpiped householder, the location of the water source (Mujwahuzi 2002, 57–60). Water availability is also influenced by environmental factors such as seasonality of rainfall, increased sediment loads in rivers due to deforestation and soil erosion, pollution and overgrazing due to increasing numbers of livestock that use the same water sources as humans, and human population increase (Mujwahuzi 2002, 61–62).

Regions most affected by inability to have adequate and clean drinking water

According to data in Kivugo (1995, 42) water coverage for all mainland regions ranged from 28.2 per cent in Shinyanga to 84.7 per cent in Mtwara. None provided 100 per cent coverage. This finding is supported by later data, collected in 2002, which show

the percentage of the rural population with access to safe water ranges from 11 per cent in Lindi to 75 per cent in Kilimanjaro (Tanzania Research and Analysis Working Group 2002, 69). Even though the two data sets are not identical, they both show that no one mainland region provided access to safe water to all of their population.

3.3 Ability to have energy to keep warm and cook

A reliable source of energy is a necessary component of human well-being, as it is required for daily activities like cooking and keeping warm. The most important source of energy in Tanzania is fuel wood, which comprises approximately 93 per cent of its energy supply (Tanzania; Monela *et al.* 1999). And, the most energy consuming task at the household level is cooking, which accounts for 90 per cent of fuel use in Tanzania (Ndekuka 1999).

State of ability to have energy to keep warm and cook

Currently, fuel wood is being consumed more quickly than it can be replaced. In 1988, there was already a deficit of almost 21 million cu m of wood per year and consumption rates are still increasing (FAO 1999a.). Both the total and per capita woodfuel consumption (47,945,000 cu m; 1.027 mt/capita/year) and household and per capita charcoal consumption (409,000 cu m; 0.017 ton/capita) have increased since 1992 (FAO 1999a).

Tanzania faces enormous energy problems: people have to go longer distances to obtain firewood; woodfuel is becoming scarcer requiring the use of low quality biomass fuels like cow dung, which also causes hazardous indoor pollution; reliance on inefficient biomass energy technologies; and the need to buy wood which was formerly a free commodity (Ndekuka 1999).

Now that fuel wood has entered the market economy and is increasingly scarce, farmers near urban areas are shifting away from farming to trading in charcoal (FAO 1999a.). A 50–60 kg bag of charcoal is worth between US$4–5 and $6–7 in the rainy season in urban areas (FAO 1999a.).

Regions most affected by inability to have energy to keep warm and cook

Women are the main users and collectors of household fuel and are the most vulnerable to energy problems. Fuel wood scarcity directly affects women, particularly those in Shinyanga, Arusha, the Kilimanjaro lowlands, Dodoma and Singida regions (Tanzania National Forest Program 2004). In these regions, women must walk at least six to 10 km to collect fuel wood (Tanzania National Forest Program 2004). As well, agro-pastoralists in Shinyanga's Meatu district are experiencing a shortage of fuel wood and dry-season livestock fodder (Kamwenda, G. J. 2002).

As urban populations are growing more rapidly than rural ones, fuel demand is also higher in these areas (FAO 1999a.). The average consumption of woodfuel per capita in five urban centres was 1.03 cu m (Dar es Salaam 0.6 cu m, Mbeya 0.99 cu m, Dodoma 0.9 cu m, Arusha 1.86 cu m, and Mwanza 0.81 cu m) (Ishengoma and Ngaga in FAO 1999a).

- Arusha
- Dar es Salaam
- Dodoma
- Kagera: Refugees (Section 2.4)
- Kilimanjaro
- Lindi: Miombo woodland degradation (Section 2.4)
- Morogoro: Miombo woodland degradation (Section 2.4)
- Pwani: Miombo woodland degradation (Section 2.4)
- Shinyanga
- Singida

3.4 Ability to earn a livelihood

The ability to earn a livelihood is essential to human well-being and is measured using various indicators such as per capita GDP, household consumption levels and so on. In efforts to identify those needing government supports, poverty lines are established using an estimate of the cost of food and non-food basic needs for individuals and families. For example, Tanzania developed a socio-economic database using 2002 data from which a "human development index" was compiled using four indicators: life expectancy at birth, knowledge measured using the adult literacy rate, primary gross enrolment ratio, and mean monthly consumption expenditure per capita (Tanzania Research and Analysis Working Group 2002).

State of ability to earn a livelihood

Tanzania's economic entitlements are low. In fact, 41.6 per cent of the population lives below the poverty line with 19.9 per cent of the population living on less than $1 a day, and 59.7 per cent living on less than $2 a day (World Resources Institute 2003a). During the 1990s, employment in the government and parastatal sectors declined from three per cent to two per cent and 1.7 per cent to 0.5 per cent respectively, while employment in the private formal sector increased from three per cent to five per cent along with a small increase in the informal sector/self-employment (Tanzania Research and Analysis Working Group 2002, 19–20). There was also a decline from 84 per cent to 81 per cent in traditional agriculture, though it remains as the main source of livelihood for the majority of the population (Tanzania Research and Analysis Working Group 2002, 19). Unemployment is highest in urban areas, particularly Dar es Salaam.

While most agriculture in Tanzania is for subsistence, there are some cash crops earning export income. Of these, coffee is the primary one and it is grown by 400,000 small-scale and mostly poor farmers who generally each own fewer than five acres of land (Technoserve 2004). Once a good export earner, income from coffee exports has steadily fallen since 1995 (World Bank 2004). Coffee is produced in the Matengo highland regions of Kilimanjaro, Mbeya and Mbinga where most of the coffee trees are lower yielding older trees; these 70-year-old trees yield .25 kg per tree while neighbouring Kenya produces up to four kg per tree (Technoserve 2004). Tanzania's second most valuable cash crop, cotton, earned the same as coffee in 2003 (World Bank 2004).

In Zanzibar, the economy is based chiefly on the production of cloves which are the main foreign exchange earner (90 per cent grown on the island of Pemba) (United States Department of State 2005). Tourism is an increasingly promising sector for foreign earnings, recording over US$500 million annually (Tanzania 2000). In recent years, a number of new hotels and resorts have been built as well (United States Department of State 2005).

Table 2. Human Development Index (HDI)

HDI rank		Life expectancy at birth (years) 1988	Adult literacy rate (% age15 and above) 2000	Primary gross enrolment ratio (%) 2000	Mean monthly consumption expenditure per capita (000 Tsh) 2000	Life expectancy index	Education index	Expenditure index	Human development index (HDI) value
1	Dar-es-Salaam	50	91	98.7	21.9	0.417	0.935	0.849	0.734
2	Kilimanjaro	59	85	104.4	11.2	0.567	0.914	0.327	0.603
3	Mbeya	47	79	99.7	12.6	0.367	0.858	0.395	0.540
4	Arusha	57	78	84.1	10.3	0.533	0.800	0.283	0.539
5	Iringa	45	81	102.5	11.2	0.333	0.881	0.327	0.514
6	Ruvuma	49	84	89.4	9.6	0.400	0.857	0.249	0.502
7	Mtwara	46	68	83.3	12.4	0.350	0.730	0.385	0.488
8	Tabora	53	65	81.3	10.4	0.467	0.704	0.288	0.486
9	Singida	55	71	94.5	6.9	0.500	0.788	0.117	0.468
10	Morogoro	46	72	87.2	10.0	0.350	0.770	0.288	0.463
11	Pwani	48	61	79.7	10.5	0.383	0.672	0.293	0.449
12	Tanga	49	67	78.4	9.3	0.400	0.707	0.234	0.447
13	Mara	47	76	88.7	8.0	0.367	0.802	0.171	0.447
14	Dodoma	46	66	86.9	8.5	0.350	0.729	0.195	0.425
15	Kigoma	48	71	80.1	7.3	0.383	0.740	0.137	0.420
16	Kagera	45	64	80.5	9.0	0.333	0.694	0.220	0.416
17	Mwanza	48	65	75.1	8.1	0.383	0.683	0.176	0.414
18	Lindi	47	58	67.6	9.5	0.367	0.611	0.244	0.407
19	Shinyanga	50	55	68.0	8.0	0.417	0.593	0.171	0.394
20	Rukwa	45	68	83.2	6.7	0.333	0.730	0.107	0.390
	TANZANIA	50	71	84.9	10.1	0.417	0.756	0.273	0.482

(Tanzania Research and Analysis Working Group 2002, 73).

Even though Tanzania has a well-developed tourism industry and mature coffee and cotton exports, 70–75 per cent of the population, mainly living in rural areas are income poor (Department for International Development 1999 in Quinn 2003, 111). In rural areas, 39 per cent of the population falls below the basic needs poverty line, while in urban Dar es Salaam 18 per cent of population falls below the poverty level (Amani, Kessy and Macha *et al.* 2004, 162).

Region most affected by inability to earn a livelihood (income poverty)

The majority of Tanzanians have not seen a reduction of income poverty during the previous 10–15 years, though there has been a slight decline in urban areas (Tanzania Research and Analysis Working Group 2002, 12). Given the high rates of poverty and lack of improvement in garnering better livelihoods for most Tanzanians, one can conclude that all regions of Tanzania are experiencing an inability to earn an adequate livelihood. This finding is supported by a "basic need poverty headcount" done for the 2000–2001 Household Budget Survey, which shows those not able to meet their basic needs range between 17.6 per cent in Dar es Salaam to 55.0 per cent in Singida (Tanzania Research and Analysis Working Group 2002, 68; Tanzania Bureau of Statistics 2002). When calculated using the human development index, the five regions with the lowest HDI are Kagera, Mwanza, Lindi, Shinyanga and Rukwa. Table 2 shows the complete ranking for regions based on the human development index.

3.5 Summary of constituents of well-being under threat

Constituents of well-being were found to be threatened in all 23 of the mainland regions. Of these, eight regions, namely Arusha, Dodoma, Kilimanjaro, Lindi, Morogoro, Pwani, Shinyanga and Singida, were experiencing distress for all four constituents examined, which translates into a large number of people not able to meet their basic daily needs for adequate nourishment, clean drinking water, energy for cooking and warmth, and earning a livelihood. An additional six regions were found to have three constituents threatened, while the remainder had two threatened constituents. One of the most striking aspects of this breakdown is pervasive water scarcity and inability to earn an adequate livelihood, as both constituents are threatened in all mainland regions; they are undoubtedly connected and mutually reinforcing since over 80 per cent of the population achieves a livelihood through subsistence farming.

Table 3. Constituents of well-being under threat/region

Region	Constituent of well-being under threat
Arusha	Adequately nourished Adequate and clean drinking water Energy Earn a livelihood
Dar es Salaam	Adequate and clean drinking water Energy Earn a livelihood
Dodoma	Adequately nourished Adequate and clean drinking water Energy Earn a livelihood
Iringa	Adequate and clean drinking water Earn a livelihood
Kagera	Adequate and clean drinking water Energy Earn a livelihood
Kigoma	Adequate and clean drinking water Earn a livelihood
Kilimanjaro	Adequately nourished Adequate and clean drinking water Energy Earn a livelihood
Lindi	Adequately nourished Adequate and clean drinking water Energy Earn a livelihood
Manyara	Adequately nourished Adequate and clean drinking water Earn a livelihood
Mara	Adequately nourished Adequate and clean drinking water Earn a livelihood
Mbeya	Adequate and clean drinking water Earn a livelihood
Morogoro	Adequately nourished Adequate and clean drinking water Energy Earn a livelihood
Mtwara	Adequate and clean drinking water Earn a livelihood
Mwanza	Adequate and clean drinking water Earn a livelihood
Pemba North	Adequate and clean drinking water Earn a livelihood
Pemba South	Adequate and clean drinking water Earn a livelihood
Pwani	Adequately nourished Adequate and clean drinking water Energy Earn a livelihood
Rukwa	Adequate and clean drinking water Earn a livelihood
Ruvuma	Adequate and clean drinking water Earn a livelihood
Shinyanga	Adequately nourished Adequate and clean drinking water Energy Earn a livelihood
Singida	Adequately nourished Adequate and clean drinking water Energy Earn a livelihood
Tabora	Adequately nourished Adequate and clean drinking water Earn a livelihood
Tanga	Adequately nourished Adequate and clean drinking water Earn a livelihood

4.
Linking Ecosystem Services to Human Well-being

In Table 4, ecosystem services stressed and constituents of well-being threatened are listed for each region. In many instances there is a high correlation between the ecosystem services and constituents of well-being that are stressed. Regions experiencing deterioration in food and fibre provision also face serious problems in meeting adequate nourishment levels. Furthermore, the regions facing drops in food production in most cases also experience problems in water supply.

Morogoro Region stands out, as it is the only region that has all four ecosystem services stressed and constituents of well-being threatened, suggesting that it should be a priority region for development efforts. In addition to Morogoro, eight regions, namely Arusha, Dodoma, Kilimanjaro, Lindi, Mara, Pwani, Singida and Tanga, are identified as having food production—inadequate nourishment and deteriorating water supply—inadequate access to safe water, highlighting a state that needs immediate action. Biodiversity is now under threat in several regions, a loss that is particularly distressing, as Tanzania has had a long tradition of conserving biodiversity, mainly through an extensive network of protected areas. No doubt this biodiversity loss is having a negative impact on ecosystem functioning. This is the case in Kilimanjaro where deforestation is contribution to soil erosion and sediment loading in rivers.

Table 4. Ecosystem services stressed and constituents of well-being threatened, by region

Region	HDI rank and value	Ecosystem services stressed	Constituent of well-being under threat
Arusha	4 0.539	Biodiversity Food production Water supply, purification and regulation	Adequately nourished Adequate and clean drinking water Energy Earn a livelihood
Dar es Salaam	1 0.734	Food production Water supply, purification and regulation	Adequate and clean drinking water Energy Earn a livelihood
Dodoma	14 0.425	Biodiversity Food production Water supply, purification and regulation	Adequately nourished Adequate and clean drinking water Energy Earn a livelihood
Iringa	5 0.514	Biodiversity Food production Water supply, purification and regulation	Adequate and clean drinking water Earn a livelihood
Kagera	16 0.416	Biodiversity Water supply, purification and regulation Fuel (energy)	Adequate and clean drinking water Energy Earn a livelihood
Kigoma	15 0.420	Biodiversity Food production Water supply, purification and regulation	Adequate and clean drinking water Earn a livelihood

Region	HDI rank and value	Ecosystem services stressed	Constituent of well-being under threat
Kilimanjaro	2 0.603	Food production Water supply, purification and regulation	Adequately nourished Adequate and clean drinking water Energy Earn a livelihood
Lindi	18 0.407	Biodiversity Food production Fuel (energy)	Adequately nourished Adequate and clean drinking water Energy Earn a livelihood
Manyara	n/a	Biodiversity	Adequately nourished Adequate and clean drinking water Earn a livelihood
Mara	13 0.447	Food production Water supply, purification and regulation	Adequately nourished Adequate and clean drinking water Earn a livelihood
Mbeya	3 0.540	Food production Water supply, purification and regulation	Adequate and clean drinking water Earn a livelihood
Morogoro	10 0.463	Biodiversity Food production Water supply, purification and regulation Fuel (energy)	Adequately nourished Adequate and clean drinking water Energy Earn a livelihood
Mtwara	7 0.488	Food production	Adequate and clean drinking water Earn a livelihood
Mwanza	17 0.414	Food production Water supply, purification and regulation	Adequate and clean drinking water Earn a livelihood
Pemba North	n/a		Adequate and clean drinking water Earn a livelihood
Pemba South	n/a		Adequate and clean drinking water Earn a livelihood
Pwani	11 0.449	Biodiversity Food production Fuel (energy)	Adequately nourished Adequate and clean drinking water Energy Earn a livelihood
Rukwa	20 0.390	Food production Water supply, purification and regulation	Adequate and clean drinking water Earn a livelihood
Ruvuma	6 0.502		Adequate and clean drinking water Earn a livelihood
Shinyanga	19 0.394	Food production	Adequately nourished Adequate and clean drinking water Energy Earn a livelihood

Region	HDI rank and value	Ecosystem services stressed	Constituent of well-being under threat
Singida	9 0.468	Food production Water supply, purification and regulation	Adequately nourished Adequate and clean drinking water Energy Earn a livelihood
Tabora	8 0.486	Food production	Adequately nourished Adequate and clean drinking water Earn a livelihood
Tanga	12 0.447	Biodiversity Food production Water supply, purification and regulation	Adequately nourished Adequate and clean drinking water Earn a livelihood

The main problem most regions confront is the management of water. Although the internal water recharge rate is sufficient to meet present withdrawal rates, most of the population still faces difficulty accessing water. The lack of appropriate technology for managing water resources is a major constraint in the sustainable management of water resources. However, technology by itself would not be sufficient. The increasing loss of forests and vegetative cover has increased the rate of run-off and less capture of precipitation. Over time, this can only imply a deterioration in the internal water recharge rate and subsequently the supply of water available. This is further compounded by an increasing demand for water by a population which is growing at an unsustainable annual rate of five per cent.

Although water is a major factor in declining food yields, other factors also contribute to the trend. Decreasing soil fertility caused by decreasing fallow periods is another main contributing factor. Smaller farms caused by increasing population forces farmers to work the land more intensively to meet subsistence needs. Allowing land to remain fallow and regain productivity is now considered a luxury. Lack of expertise in using fertilizers and a decreasing supply of natural fertilizers from cattle has contributed to decreasing land productivity. Another factor in the pastoral areas is the growing herd size which has put greater pressure on grazing resources.

Although much information has been gathered in this review, much remains to be learnt before intervention strategies can be developed. A locally-based integrated assessment, whereby more detailed information on the links between ecosystem services and well-being and the type of trade-offs and synergies that occur among these links, will provide policy-makers in Tanzania the necessary information to make the necessary intervention to achieve some, if not most, of the Millennium Development Goals.

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