Connecting poverty & ecosystem services

A series of seven country scoping studies

Focus on Mozambique

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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 Mozambique 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, Rwanda, Tanzania 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. Immediate areas of concern include the rapid rates of deforestation which are connected to several problems including loss of biodiversity, coastal erosion, droughts and flooding and increasing levels of water pollution.
2. The ongoing challenges in rebuilding after the long civil war, resettlement of millions of people and in the face of recurring natural disasters are enormous.
3. Gaza, Manica, Nampula, Sofala and Tete stand out as all five ecosystem services and well-being constituents are threatened.
4. Better management of ecosystem services could go a long way in alleviating the profound needs of the people in this country. For example, deforestation has increased the frequency of floods and droughts. Similarly, unsustainable clearing of land for agriculture has contributed to drops in soil fertility.
5. The provinces with the highest population densities, Nampula and Zambezia, should also be a priority. In Nampula, 42 per cent of children suffer from chronic malnutrition, and only 32 per cent of the population has access to clean water while in Zambezia, 47 per cent of children suffer from malnutrition and only 13 per cent of the population has clean water.

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

	Maintenance of biodiversity	Food production	Water supply	Energy resources	Flood regulation	Adequately nourished	Clean water	Energy for warmth and cooking	Earn livelihood	Vulnerability to flood and drought
Cabo Delgado	X	X	X	X	O	X	X	X	X	O
Gaza	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Inmambane	X	X	X	X	O	X	X	X	X	X
Manica	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Maputo	X	X	X	X	O	X	X	X	X	X
Nampula	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Niassa	X	X	O	X	O	X	X	X	X	O
Sofala	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Tete	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Zambezia	X	X	X	X	O	X	X	X	X	O

- 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 disruptions caused by years of civil unrest are still being felt in Mozambique. During the civil war, huge numbers of people were displaced and many migrated to coastal areas or to other surrounding countries and millions returned in the mid-1990s. In this situation, immediate survival was primary, hence up-to-date information on ecosystem services was difficult to find and many data gaps exist.

Maintenance of biodiversity

Rapid deforestation and habitat fragmentation due to wood extraction and selective logging and the conversion of habitat to agricultural systems has contributed to the loss of variability, which is particularly evident in mangrove forests. These forests are threatened by increased population growth, excessive harvesting for fuel wood as well as expanding agriculture. In addition to provisioning services, these mangrove forests also protect coral reefs by filtering sediment and silt. The exploitation of mineral resources also exacerbates forest devastation.

Food and fibre provision

Mozambique is extremely vulnerable to variation of rainfall causing both droughts and floods. Smallholder subsistence farming accounts for 95 per cent of the areas under cultivation, and fishing is one of the most important sections of the national economy. Livestock do not contribute to the economy, but do provide vial supplemental nutrition. Seven of the 10 provinces are affected by drought or desertification and one of the main factors is the removal of vegetation through desertification and heavy rainfall reduces soil fertility. As well, salt intrusion in the dry season increases the risk of land degradation from salinization. With the loss of mangrove forests, coastal erosion has translated into loss of habitat, food and protection for many nutritionally and economically viable species of fish.

Water supply, purification and regulation

Pollution of surface and coastal waters is an emerging problem in Mozambique with urban areas, industry and agro-industries having a large impact on their surrounding populations. Domestic water contamination in rural, urban and peri-urban areas is also rife with adequate treatment of sewage occurring in only two per cent of families in Mozambique. Wetlands provide water purification and regulation, but are threatened from expanding agriculture, population growth and "distress migration." The severity of recent floods is another indicator that water regulating ecosystem services are stressed.

Fuel provision

Forests are being cleared for agriculture and fuel needs for the high concentration of people in some areas due to internal migration and displacement. As well, population growth in urban areas and along main road corridors leads to a dramatic increase not only in the requirement for agricultural land, but for forest, fuel and wildlife products. Fire is often employed to clear land, which often leads to uncontrollable wildfires.

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

Nearly 80 per cent of the Mozambican population relies on agriculture as a main source of food for subsistence and as a result, is the main factor in the inability to grow food. Soil infertility and desertification are also impacting heavily on farmers' ability to grow enough food. Food supply nationally is making impressive gains since the end of the civil war, but uneven spatial distribution of food supply, of natural disasters and land desertification cause local food insecurity. Food prices also vary across the country which is attributed to the deterioration of the national road.

Ability to access clean water

Only 36 per cent of the population of Mozambique has access to safe water and many communities have broken or contaminated water sources. This is in direct correlation with the information found on water supply and quality and water-related provisioning and regulating services are clearly related to the ability of the population to enjoy clean and safe water.

Ability to have energy to keep warm and cook

With few energy alternatives available, the majority of urban households are also dependent on charcoal and woodfuel, and this is amplified in the densely populated coastal regions when Mozambicans cut trees to satisfy fuel requirements. Deforestation rates are increasing which is hindering not only Mozambicans' ability to have sustainable energy supplies, but also impacts on soil fertility, water quality and biodiversity. Due to a lack of data on fuel wood consumption, deforestation rates provide a proxy indicator.

Ability to earn a livelihood

Mozambique's economic entitlements are low, with 70 per cent of the population living below the poverty line. Subsistence agriculture employs the vast majority of the country's workforce, though there are several cash crops grown by many small landholders. However, natural disasters such as droughts and floods interrupt farm production and the ability earn a living generally. Unfortunately, the level of poverty in the country substantially reduces resilience in the face of disasters and the effects are cumulative as natural assets in the form of soil, biodiversity, etc. decline.

Ability to be secure against extreme events such as droughts and floods

One of the striking features of Mozambique is the extreme vulnerability of the population from the hazards of droughts and floods. However, with the decline in ecosystem services, particularly water regulating services, the ability of ecosystems to catch and store rainfall is highly compromised. The population of the country that is reliant on subsistence agriculture (80 per cent) is particularly vulnerable to floods and a repetitive cycle of floods and droughts can easily cause a downward spiral of impoverishment.

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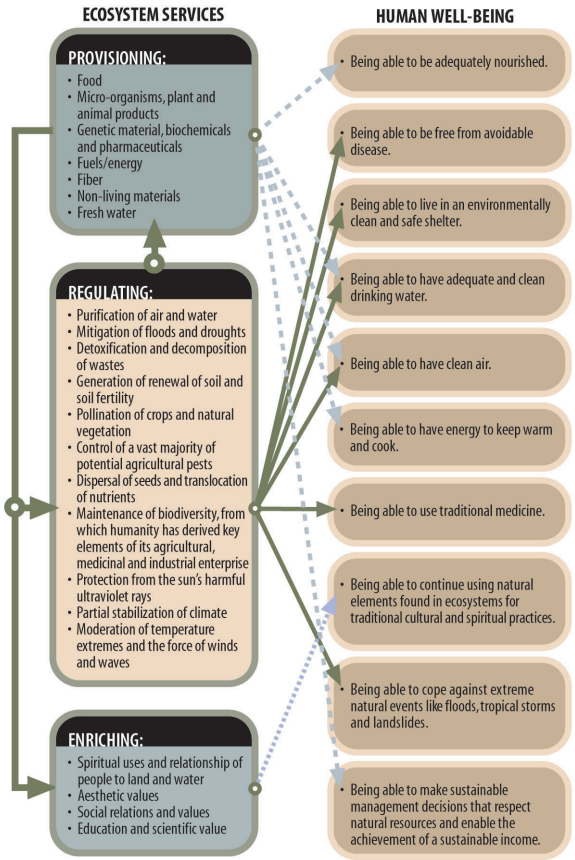
Introduction

The primary objective of this report is to identify regions within Mozambique 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 Mozambique. 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 Mozambique 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 provincial level. By taking this unique approach and using a finer spatial lens, areas where human-ecosystem areas are stressed emerge and clarify difficult trade-offs being made locally.

This report is organized into four sections with the first briefly describing the people and landscape of Mozambique, thus providing a backdrop for the rest of the overview. Section 2 scopes out the main ecological services stressed and pinpoints their location at the provincial level. Section 3 then discusses the related constituents of well-being which are increasingly being threatened by these deteriorating ecosystem services, and as with ecosystem services, locates them provincially. The concluding section co-locates those provinces where ecosystem services are stressed with those where the constituents of human well-being are threatened and then briefly outlines where difficult are being made to help guide priorities.

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

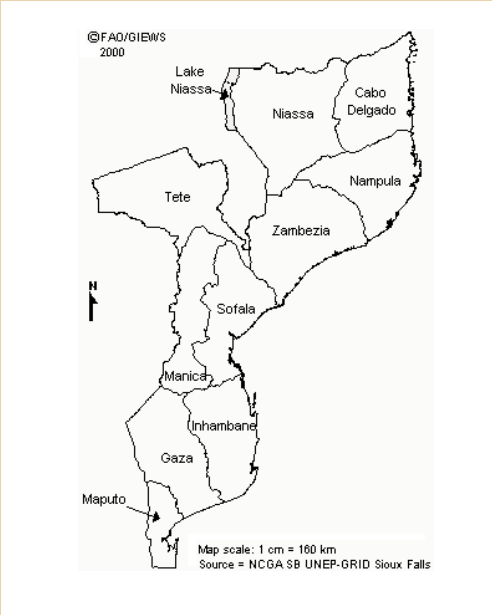


(Source: Duraiappah 2002)

1. Mozambique in Brief

The destruction of Mozambique's civil war, which ended in 1992, continues to overshadow the natural beauty and cultural richness of this southern African country. Mozambique is naturally endowed with a diverse landscape ranging from coastal plains to savannah and woodlands to mountains. And, there are numerous rivers flowing from east to west into the Indian Ocean, with the Zambezi and Limpopo being the two largest.

Map 1. Mozambique provinces (FAO GIEWS 2000)



Mozambique: Area and provinces

Total area:	799,390 sq km
Freshwater area:	13,000 sq km
Land area:	786,380 sq km

Administrative Regions: The Republic of Mozambique is divided into three regions: the South (Maputo, Gaza and Inhambane provinces), the Centre (Sofala, Manica, Tete and Zambezia provinces) and the North (Nampula, Cabo Delgado and Nisassa provinces). Each province is sub-divided into districts which are sub-divided into administrative localities and posts.

(Matimula 2003; Mozambique Instituto Nacional de Estatistica 2005; World Resources Institute 2003c)

It is also one of the cradles of civilization; humans are believed to have first settled there some 100,000 years ago, and by the year 1000 there were well-established towns and trading posts along the coast linked to other parts of Africa, the Middle East and India (Lonely Planet 2004). Vasco da Gama arrived in 1498 and the Portuguese overcame local resistance and established their presence in the country until 1975. Then, the fledgling state tried to establish a socialist system of government and economy, which floundered and contributed to the ensuing civil war. During this time millions of Mozambicans were displaced and, of these, approximately five million returned and settled in the mid-1990s. Unfortunately, many of the thousands of land mines laid during the civil war in all 10 provinces still need to be cleared and destroyed before a full recovery can take place (UN Mine Action 2005).

1.1 Physical geography and natural environment

Mozambique consists of tropical dry forest throughout most of its interior, while tropical moist deciduous forest follows the coast and reaches into the northern region adjacent to Tanzania (FAO Forestry Department 2000a). There are four distinct ecosystem types: cropland/natural vegetation mosaic covering 38 per cent; shrub-lands, savannah and grasslands covering 37 per cent; forest covering 22 per cent; and wetlands and water bodies covering two per cent. Sparse vegetation or barren land covers the remaining one per cent (World Resources Institute 2003f).

Climate

"Climate varies from tropical and subtropical conditions in the north and central parts of Mozambique to dry semiarid steppe and dry arid desert climate in the south" (FAO Land and Water Development Division 2005). The country's average annual precipitation is 1,032 mm in the rainy season, which lasts from October to April, and ranges from a low of less than 400 mm on the boundary with Zimbabwe to 500–600 mm in the south to 1,000–2,000 mm in north and central areas (FAO Land and Water Development Division 2005). In winter, tempera-

tures average 21°C in the north and 18°C in the south, while summer temperatures average about 27°C along the coast and lower in upland areas (United States Central Intelligence Agency 2004). The country faces frequent droughts, some of which occurred in 1974–84, 1991–92 and 1994–95 (Mendes *et al*. 1998).

Topography

Mozambique consists of three basic geographic divisions: the coastal belt has an elevation of less than 200 m and covers 44 per cent of the country; the middle plateau ranges from 200–1,000 m in elevation and covers roughly 29 per cent of the country; and the plateau highland region has an elevation averaging 1,000 m and covers 27 per cent of the country to the north of the Zambezi River (FAO Land and Water Development Division 2005). The coastal lowland is narrow in the north but widens considerably as it goes south. With the exception of the highland zone toward the western border, the land is generally a low-lying plateau of moderate height, descending through a sub-plateau zone to the Indian Ocean (FAO Forestry Department 2003).

Hydrology

Mozambique has 104 identified river basins draining the central African highland plateau to the Indian Ocean and more than 100 lakes, lagoons, marshes, wetlands, dams and aquifer formations (FAO Land and Water Development Division 2005; Mendes *et al.* 1998). The major rivers, namely the Zambezi, Rovuma, Limpopo and Messalo, cross the country eastward toward the Indian Ocean. Some rivers such as the Zambeze have their main catchments as far away as Angola. The two main lakes, namely Lake Niassa (30,600 sq km) and Lake Chirua (1,000 sq km) are shared with the neighbouring country Malawi. The coastal strip covers most areas south of the Save River and lower Zambezia Province and includes extensive wetlands (FAO Land and Water Development Division 2005).

Arable land

Arable and permanent croplands cover 4.2 per cent of Mozambique's total land area with total cultivated land covering 3,350,000 ha, providing 187 ha of cropland for every 1,000 people (World Resources Institute 2003). The most fertile part of the country is the north and central regions through which the Zambezi flows. In the northeast and higher altitude areas, the soils consist largely of fertile light clay while the southern region and the coastal plains have sandy soils, except for the rich alluvial deposits of the major rivers and streams (Mendes *et al*. 1998).

1.2 Demographics

Approximately 70 per cent of Mozambique's 19 million plus inhabitants live in rural areas (Boyd, Pereira and Zaremba 2000, 11). Population density is 24.3 people per sq km and the provinces of Zambezia and Nampula are the most populous with 39 per cent of the total populatio (Mozambique Instituto Nacional de Estatistica 2005). "Mozambique's 10 major ethnic groups encompass numerous subgroups with diverse languages, dialects, cultures and history; the largest are the Makua and Tsonga. The north-central provinces of Zambezia and Nampula are the most populous, with about 40 per cent of the population. The estimated four million Makua are the dominant group in the northern part of the country—the Sena and Ndau are prominent in the Zambezi valley, and the Tsonga dominate in southern Mozambique" (U.S. State Department Background Notes 1996).

Box 1. Mozambique: Demographics

Population:	
Total:	19,420,036
0–14 years:	43.6%
15–64 years:	53.7%
65 years and over:	2.7%
Life expectancy at birth (2002):	
Average:	38.5 years
Male:	36.9 years
Female:	40.0 years
Fertility rate (2000–2005):	
Number of births per woman:	5.6
Annual population growth rate (per cent):	2.4
Population density (inhabitants per sq km):	
Average:	24
Most dense province: Zambezia and Nampula:	28–35
Least dense province: Niassa:	6
Ethnic groups:	
Indigenous tribal groups: (Shangaan, Chokwe, Manyika, Sena, Makua, and others)	99.66%
Europeans:	0.06%
Euro-Africans:	0.20%
Indians:	0.08%
Languages:	
Portuguese (official), indigenous dialects	

(Mozambique Instituto Nacional de Estatistica [2005]; United Nations Development Programme 2004; World Resources Institute 2004; FAO GIEWS 2001; Matimula 2003)

1.3 Economy: Observable constraints

Since the end of civil war in 1992, Mozambique has shown remarkable economic growth (Bethelemy, Kauffmann and Wegner 2004). During the period from 1991–2000, the country's average annual growth in GDP was five per cent, translating into three per cent growth per capita (World Resources Institute 2003d). In 2000, however, floods reduced growth to 1.5 per cent and then in 2001, through reconstruction, the assistance of donors and good performance of the MOZAL aluminum smelter, the GDP grew 13 per cent (Bethelemy, Kauffmann and Wegner 2004). Growth in GDP has been sustained since then; in 2002, despite drought conditions in the south and central regions it grew 7.7 per cent; in 2003, the good performances of manufacturing, transport, communications and trading resulted in 6.8 per cent growth; and in 2004 and 2005, national level growth reached 8.4 per cent and 8.7 per cent respectively (Bethelemy, Kauffmann and Wegner 2004).

Box 2. Development and macro-economic indicators

Natural resources:
Coal, titanium, natural gas, hydropower, tantalum, graphite, iron ore, semi-precious stones, and arable land

GDP (constant 1995 $US), 2002: 3.6 billion

Allocation of GDP by sector, 2002:

Agriculture:	22%
Cotton, cashew nuts, sugarcane, tea, cassava (tapioca), corn, coconuts, sisal, citrus and tropical fruits, potatoes, sunflowers, beef, poultry	
Industry:	25%
Aluminum, consumer goods, chemicals (fertilizer, soap, paints), light machinery, garments and textiles, petroleum products, cement, glass, asbestos, tobacco, food, and beverages	
Services:	51%
Fishing:	2%

Main foreign exchange sector
Imports (2003): $1.24 billion
Mineral products, merchandise and nonspecific goods, machinery equipment and electrical machinery
Exports (2003): $910 Million
Metal (aluminum) and products, prawns, cashews, cotton, sugar, timber, sorghum, copra, tea, citrus fruit, bananas, tobacco and bulk electricity

Main employment sector:
Agriculture employs 82.7% of the total workforce (1990)

Per capita income (per year): US$210

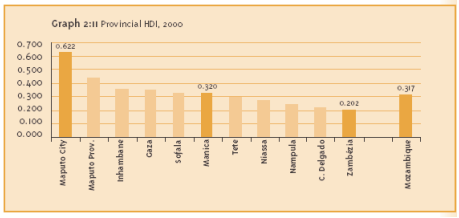
Income distribution:

Gini coefficient (where 0=perfect equality, 100=perfect inequality):	40
Percentage of total income earned by the richest 20% of the population:	46.5%
Percentage of the total income earned by the poorest 20% of the population:	6.5%

Adult literacy rate (per cent ages 15 and above):	46.5
Human Development Index (HDI):	0.354[2]
Human Development Index (HDI) rank (out of 177):	171

(Mozambique Instituto Nacional de Estatistica 2002; U.S. Department of State 2005; World Resources Institute 2003d; World Resources Institute 2003; African Forum and Network on Debt and Development 2003; United Nations Development Programme 2004.

2 HDI Index Comparison. United Nations Development Programme 2001, 27.



Despite these gains, however, Mozambique is among the 10 poorest countries worldwide and remains dependent on foreign assistance for a sizeable portion of its annual budget (Matimula 2003). It is a "highly indebted country" which in 2000 received per capita aid of $57 (Institute for Development Studies SLSA Team 2003, 17). A considerable trade imbalance also persists although the country's largest foreign investment project to date, MOZAL, has increased export earnings (United States Central Intelligence Agency 2004). Additional investments in processing and garment manufacture show promise of further closing this import/export gap. In addition, Mozambique's once substantial foreign debt has been reduced through rescheduling under the IMF's Heavily Indebted Poor Countries (HIPC) and Enhanced HIPC initiatives, and is now more manageable (United States Central Intelligence Agency 2004).

2. State of Ecosystem Services

The literature review identified biodiversity, food and fibre production, water access and quality, flood regulation, and energy resources as the five critical ecosystem services stressed[3] in Mozambique. Each is discussed in detail below along with some of the main factors influencing their deterioration and, where possible, the provinces in which they are declining are identified. In some instances, for example water, there may be deterioration in more than just one ecosystem service, which is linked to various environmental problems, while in other instances, we might see how unsustainable use of one ecosystem service may be causing a deterioration in another ecosystem service which is subsequently the underlying reason for a particular environmental problem. We start with biodiversity, which is maintained by ecosystems and underpins ecosystem functioning and hence determines the availability of ecosystem services overall.

2.1 Maintenance of 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 *et al.* 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 evidence, both theoretical and empirical, of a much more complex relationship between biodiversity—defined as the variability among living organisms, including diversity within species, between species and of ecosystems—and ecosystem services. Species perform many services for ecosystems. For example, in many ecosystems, there are a variety of species which 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 function, the higher is the level of redundancy in the system.

"Functional biodiversity (the variety of different ecological functions in a community independent of its taxonomic diversity) shows patterns of association (biota typical of wetlands, forests, grasslands, estuaries, and so forth) with geography and climate known as biomes with ecosystems and ecoregions being smaller divisions of biomes (Duraiappah and Naeem 2005, 21). Based on this and according to a terrestrial eroregion[4] mapping classification developed by the World Wildlife Fund Conservation Programme, the five largest ecoregions[5] in Mozambique and their approximate location by province are:

1. Eastern miombo woodlands (AT0706): Niassa, Cabo Delgado, Nampula and Zambesia provinces
2. Zambezian and Mopane woodlands (AT0725): Tete, Sofala, Gaza and and parts of Inhambane and Maputo provinces
3. Eastern Zimbabwe montane forest-grassland mosaic (AT1006): Manica and Tete provinces
4. Zambezian coastal flooded savannah (AT0906): Sofala Province
5. Southern Zanzibar-Inhambane coastal forest mosaic (AT0128): coastal areas of Cabo Delgado, Nampula, Zambezia, Sofala, Inhambane, Gaza and Maputo provinces

State of maintenance of biodiversity

Unfortunately little is known about the level of biodiversity in Mozambique due to the long period of civil unrest (Hatton and Munguambe 1997, 4). However, the country has historically been home to an impressive array of biodiversity. It boasts 5,692 known higher plant species; 179 known mammal species; 144 known breeding birds; 195 known reptiles; 52 known amphibians; and 524 known fish species, and supports 10 mangrove species; eight seagrass species; and 49 genera of scleractinia coral

3 Ecosystem services found to be deteriorating or in the danger of being deteriorated in the near future.

4 For the purposes of this discussion, ecosystems and ecoregions are considered to be the same spatial unit.

5 Derived from map "Terrestrial Ecoregions of the World" at: http://www.nationalgeographic.com/wildworld/terrestrial.html?id=1&mapServiceName=WW_Terrecos&locWidth=120&locHeight=72&cMinx=30.213017&cMiny=-26.860279&cMaxx=40.846107&cMaxy=-10.471111&size=small&detail=detailed

(World Resources Institute 2003a, 2003c). Some of this biodiversity is conserved through a network of 35 protected areas covering 5.7 per cent of total land area and mainly located in Niassa, Cabo Delgado, Zambezia, Sofala, Gaza and Manica provinces (FAO Forestry Department 2000b; World Resources Institute 2003a). This network protects 7.5 per cent of Mozambique's tropical forest and 6.6 per cent of its sparse trees and parkland (World Resources Institute 2003f). One of the protected areas, Niassa Reserve, is among the largest protected miombo forest ecosystems in the world and is the largest conservation area in Mozambique (Sociedade de Gestao e Desenvolvimento da Reserva do Niassa, 2002). In addition, Mozambique has seven marine or littoral protected areas, including one National Marine Reserve, thus protecting four per cent of its 5,646 sq km of mangrove forest (World Resources Institute 2003a, 2003c).

There are seven critically endangered and 27 endangered species in Mozambique and, of these, two are critically and six endangered plant species (IUCN 2004). In addition, there are 43 threatened tree species (World Resources Institute 2003f). Among its critically endangered animals are the black rhinoceros, the long-billed apalis bird, Vincent's bush squirrel, the leatherback turtle and hawksbill sea turtle (IUCN 2004). Mangroves and coral reefs are among the most threatened natural ecosystems in Mozambique. There are, however, no details on the threatened status of 1,919 species in Mozambique (United Nations Environment Network 2005).

Examples of biodiversity use[6]

Savannah and secondary forest covering 70 per cent of the country, including mixed crop land, represent the primary source of biodiversity, genetic resources and biochemical ecosystem services (Mendes *et al.* 1998). Among these are the miombo woodlands, which provide many non-wood forest products (FAO Forestry Department 2000). They are the most common vegetation type in the country and extend from the Rovuma River in the north to the Limpopo River mouth in the south and the miombo woodland Niassa Reserve covers parts of Cabo Delgado Province and nearly one-third of Niassa Province (FAO 1999; Sociedade de Gestao e Desenvolvimento da Reserva do Niassa 2002).

Mozambicans, particularly in rural areas, derive many basic needs from non-wood forest products such as bush meat, honey, beeswax, grass, bamboo, reed, medicinal plants, mushrooms, and a variety of edible plants and fruits (FAO Forestry Department 2000). In the rural coastal plains, communities use 76 edible wild plant species while in southern Mozambique 41 edible fruit species are found (FAO Forestry Department 2000). In the north, in a miombo forest[7] remnant in Senhote, 144 tree species with multiple uses exists; trees in this area bear fruits through different seasons even during drought years and, as such, are a highly important food source that can be eaten, cooked or roasted as seeds and nuts, or eaten as a flower (FAO Forestry Department 2000).

Traditional medicinal plants found in forests are also important, as 60 per cent or more of the population has access to only traditional medicines (Prometra Moçambique 2005). Communities in Cabo Delgado Province, for example, have a long tradition of using medicinal plants including 16 species of plants belonging to 13 families that they use to treat coughs, headaches, liver problems, measles, diarrhea, injuries and rheumatism (Matavele and Habib 2000). In urban areas, some medicinal plants can be bought at the markets (Matavele and Habib 2000). In Mozambique's central region, people use 10 medicinal ethnospecies, and in the south they use 18 (Matavele and Habib 2000). Mozambique's traditional medicines also benefit South Africans, as 33 per cent of the 176 plant species available in South Africa's Mpumalanga Province markets are from Mozambique (Botha, Witkowski and Shakleton 2004).

Mangroves provide Mozambicans with poles and timber for building houses, fences, fishing stakes for drying fish catches, the construction of furniture, and small branches for use as firewood and charcoal (FAO 1999; Mendes *et al.* 1998). Mozambique's most important mangroves are located in the estuary rivers: the Messalo in Cabo Delgado Province, Zambezi in Zambezia Province, Pungue in Sofala Province, Save in Sofala Province, Limpopo in Gaza Province and

6 Few studies link changes in biodiversity with changes in ecosystem functioning to changes in human well-being (Duraiappah and Naeem, 2005, 22). This particularly applies to studies on biodiversity links to regulating services. Hence, the only examples found were on provisioning services.

7 Miombo woodlands are characterized by the dominance of trees in the Brachystegia and Julbernardia genera, with a canopy height of less than 15 m, in typically acidic soils which receive less than 1,000 mm of rain a year (FAO; Duarte-Mangue and Oreste 1999, 1999).

Maputo in Maputo Province (Duarte-Mangue and Oreste 1999, 7). The coastal district of Dondo in Sofala suffers the greatest deterioration of its mangrove ecosystem due to uncontrolled mangrove tree harvesting for charcoal and firewood (FAO 1999). From 1972 to 1990, people in Sofala removed the largest area of mangroves of any province: 6,334 ha, or 4.9 per cent of its system (Duarte-Mangue and Oreste 1999). During the same time, Maputo Province depleted its mangroves by 2,217 ha or 15.2 per cent and Zambezia removed 3,766 ha, or 2.4 per cent of mangroves (FAO 1999). There is evidence, however, that communities can sustainably use mangrove forest products in the coastal zone of Marromeu, Sofala Province and in Gaza and Cabo Delgado, for example, mangroves have not been depleted at all (FAO 1999).

Factors influencing biodiversity loss

Rapid deforestation and habitat fragmentation due to wood extraction and selective logging and the conversion of natural habitat to agricultural systems has contributed to the loss of variability across ecosystems. This is particularly evident in many of the mangrove forests along the coasts, which saw increased pressures as people migrated to urban and coastal areas because of the civil war and droughts in the hinterland. These forests are threatened by excessive harvesting for fuel wood as well as expanding agriculture, fish and shrimp farming tanks, salt pans and traditional applications which exceed sustainable production and do not permit regeneration (Ghazvinian 2004; Mendes 1998). In addition to provisioning services, mangroves protect coral reefs[8] by trapping sediment and silt in their roots and when this protection is lost, as in 2001–2002, floods damage coral reefs (Obura *et al.* 2002).

The exploitation of mineral resources also exacerbates forest devastation and changes in the equilibrium of specific ecosystems through the movement of great amounts of land; the emission of toxic gases and the disturbance of water levels as well as the destruction of vast forest areas (Mendes *et al.* 1998). In Sofala Province, erosion related to mining activities has caused a disastrous situation which endangers the sanctuary of Nova Sofala (Mendes *et al.* 1998).

Many species are negatively impacted by habitat loss as well as being from hunted for food and traditional medicine. Examples include Vincent's bush squirrel, the black rhinoceros, the leatherback turtle and hawksbill sea turtle which also suffer from accidental mortality in fishing nets and commercial and industrial water pollution. Last, elephant poaching for ivory continues to be a problem (FAO Forestry Department 2000).

Provinces most affected by biodiversity loss

- Cabo Delgado: Eastern miombo woodlands threatened by deforestation, poaching and mining
- Gaza: Negative impacts of mining on biodiversity; Zambezian and Mopane woodlands threatened by poaching and exploitation of wildlife; Southern Zanzibar-Inhambane coastal forest mosaic threatened by forest clearing for agriculture and commercial logging
- Inhambane: Zambezian and Mopane woodlands threatened by poaching and exploitation of wildlife; Southern Zanzibar-Inhambane coastal forest mosaic threatened by forest clearing for agriculture and commercial logging
- Manica: Negative impacts of mining on biodiversity; Eastern Zimbabwe montane forest-grassland mosaic threatened by clearing for agriculture and contains landmines
- Maputo: Deterioration of mangroves; negative impacts of mining on biodiversity; Zambezian and Mopane woodlands threatened by poaching and exploitation of wildlife; Southern Zanzibar-Inhambane coastal forest mosaic threatened by forest clearing for agriculture and commercial logging
- Nampula: Eastern miombo woodlands threatened by deforestation, poaching and mining; Southern Zanzibar-Inhambane coastal forest mosaic threatened by forest clearing for agriculture and commercial logging
- Niassa: Eastern miombo woodlands threatened by deforestation, poaching and mining

8 Corals play a large role in the tourism industry as well (Ghazvinian 2004).

- Sofala: Deterioration of mangroves; negative impacts of mining; Zambezian and Mopane woodlands threatened by poaching and exploitation of wildlife; Zambezian coastal flooded savannah threatened by dam construction, poaching, human settlements, agriculture development and population growth; Southern Zanzibar-Inhambane coastal forest mosaic threatened by forest clearing for agriculture and commercial logging
- Tete: Negative impacts of mining; Zambezian and Mopane woodlands threatened by poaching and exploitation of wildlife; Eastern Zimbabwe montane forest-grassland mosaic threatened by clearing for agriculture and contains landmines
- Zambezia: Eastern miombo woodlands threatened by deforestation, poaching and mining; Southern Zanzibar-Inhambane coastal forest mosaic threatened by forest clearing for agriculture and commercial logging

(Goldberg 2001, 2001a; Spriggs 2001; Schipper and Burgess 2001; Estes and Greyling 2001)

2.2 Food and fibre provision

Ecosystems provide the medium for growing the food on which humans and domesticated animals depend; 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.

Naturally-occurring constraints to food provision services in Mozambique include periodic severe droughts and low to medium climatic production potential throughout all its regions (Mendes *et al.* 1998). It also suffers from low soil suitability in the Tete Province and steep slope and mountains in Tele and Manica provinces, limiting cultivation (FAO 1999). The greatest risk of erosion occurs in the central provinces of Manica, Tete and Zambezia (Menete 2000). In addition, devastating cyclones and floods occur in central and southern provinces (United States Central Intelligence Agency 2004).

Small-holder subsistence farming accounts for 95 per cent of the area under cultivation and food products mainly consist of roots and tubers (73.8 per cent), cereals (22.7 per cent), pulses (2.2 per cent) and meat (1.2 per cent) (FAO Land and Water Development Division 2005; World Resources Institute 2003). Mozambicans obtain their daily calories predominantly from roots and tubers (40 per cent) and cereals (38 per cent), followed by oils (12 per cent), pulses (three per cent), vegetables and fruits (two per cent), meat and poultry (two per cent), sugars (two per cent), and milk, eggs and animal products (one per cent) (FAO GIEWS 1997a). Maize and cassava are two important crops that are widely grown (Mozambique Instituto Nacional de Estatistica 2003).

Mozambique's predominant commercial and cash crops are sugarcane, cotton and cashew nuts (Bethelemy, Kauffmann and Wegner 2004). Farmers also grow sweet potato, onion, tomato, pumpkin, watermelon, cabbage and lettuce which are an important source of income during winter, particularly for households that live close to urban centres (Matimula 2003).

Fishing is one of the most important sectors of the national economy; it represented 40 per cent of the country's exports in 1994, and occupies 50 to 60,000 of the active population (World Resources Institute 2003c). Fishing activity is concentrated in the coastal provinces of Maputo, Inhambane, Sofala, Zambezia and Nampula (Mozambique 2001; Mozambique. Instituto Nacional de Estatistica 2003a). Mangroves also provide fishery resources which alone contribute 45 per cent of the external revenue of the country (Duarte-Mangue and Oreste 1999). As well, interior waters including lakes and dammed flood plains constitute an area of about 30,000 sq km with good fishing conditions (Mendes *et al.* 1998).

Livestock do not contribute largely to the economy but provide vital supplemental nutrition and Mozambicans consume on average five kg of meat per person annually (World Resources Institute 2003e). Farmers raise chickens (98 per cent), ducks (57 per cent), goats (26 per cent), pigs (13 per cent), Guinea pigs (13 per cent), cattle (seven per cent), pigeons (four per cent), and sheep (less than one per cent) (Alders, Fringe and Mata 1997). Relative to other southern African counties, there are few cattle; they

are found in greatest concentrations (20–50 animals per sq km) in pockets of Maputo, Manica, Sofala, Inhambane, Tete, Nassa and Cabo Delgado provinces (FAO 2002).

A wide variety of non-wood forest products are harvested and marketed in rural communities to meet important subsistence needs, but information on the level of production and their extent of use is not available, except for exports of medicinal plants, which are documented. Wild animal products and bush meat are important sources of food as well as wild vegetables, fruits and tubers, some of which are marketable (FAO Forest Department 2000).

State of food and fibre provision services

Current levels of food productivity are relatively low, especially in southern regions. Although this level of production could supply the country with the basic foodstuffs, the diet would be insufficiently diversified and a significant degree of food insecurity would still occur at the household level (Mozambique 2001). Even though there has been a steady recovery in agricultural production over the past several years, especially cereal production which has more than doubled since 1992, the country as a whole regularly faces a food deficit (Forum for Food Security 2004, 11). This deficit in local production is made up through the importation of maize, rice and flour (Matimula 2003, 6).

After a decline in livestock numbers during the civil war, growth continues to be hampered by livestock disease and lack of veterinary services (Alders, Fringe and Mata 1997; Mozambique Instituto Nacional de Estatistica 2003). Even so, annual meat production has been gradually increasing and was at an all-time high of 95,000 mt in 2000 (United Nations Environment Network 2005). Despite this increase, meat production per capita is still at the lowest point in recorded history, at 4.9 kg per person annually (United Nations Environment Network 2005).

Average annual marine fish capture is 25,965 mt, while mollusk and crusteacean capture is 13,565 mt (World Resources Institute 2003c). Inland freshwater fish catch inland has tripled since the early 1990s, and by 1999, was at approximately 12,000 mt (United Nations Environment Network 2005). In addition, total aquaculture produced one mt in 2000 (World Resources Institute 2003c). Even though exports in fish and fish products have increased 403 per cent since 1980 to US$103,537,000 annually, per capita food supply from fish was merely three kg per person in 2000 and fish protein only constitutes two per cent of total protein supply (World Resources Institute 2003c).

Factors influencing food and fibre provision service

Mozambique is extremely vulnerable to variation in rainfall causing both droughts and floods which constrain food provision (Mendes *et al.* 1998). In 1982–1984, a drought and famine displaced millions of rural people into Maputo and other urban centres which were already suffering serious food shortages (Mendes *et al.* 1998). More recently, the drought in 1991–1992 affected three million people and in 2001, Maputo, Gaza and Inhambane experienced a dry spell which reduced maize and bean crops (United Nations Environment Network 2005; FAO GIEWS 2001). Ironically, in the same year, torrential rains and high water levels in the Zambezi River flooded and destroyed 77,000 ha of food crops in the central provinces of Zambezia, Sofala, Manica and Tete (FAO GIEWS 2001).

Seven of the 10 provinces are affected by drought and/or have a tendency to desertification.[9] One of the main factors responsible is the removal of vegetation, especially through deforestation and heavy rainfall that reduces soil fertility by washing out the organic layer and nutrients. In Mozambique, the intensity of rainfall increases from south to north, but with considerable regional differences in the frequency of breaks in heavy rainfall, creating high risk zones in mountainous areas and the coastline. In the coastal zone, salt intrusion in the dry season increases the risk of land degradation from salinization, especially at high tide (Mendes *et al.* 1998). In addition, some areas are experiencing a rainfall deficit and reduction of water in river tributaries partly due to withdrawals in neighbouring countries.

Coastal erosion has increased with the loss of wetlands and wetland mangrove forests, which grow near the ocean and provide a shield of protection along coastlines (Mendes *et al.* 1998). These areas are under threat from agriculture, fish ponds, and harvesting of fibre, fuel and charcoal. Unfortunately, coastal degradation translates into the loss of habitat, food and protection for many nutritionally and economically important species of fish and crustaceans (FAO 1999; Mendes *et al.* 1998).

9 The causes of desertification are not the same for all provinces. See Table 1 for a list of areas affected by drought or with a tendency to desertification.

Table 1. Area affected by drought or with tendency to desertification

Province	Districts	Principal causes
Maputo	Moamba	Insufficient surface water, lower precipitation, uncontrolled burn, tree cutting for production of charcoal and firewood
	Namaacha	Reduction of water flow in river tributaries, deficit rainfall, uncontrolled burn, trees cut for charcoal production and firewood
	Magude	Reduction of water flow in river tributaries, deficit rainfall, erosion, uncontrolled burn, trees cut for charcoal , firewood and wood
Gaza	Mabalane Chicualacuala Massagena, Massingir and Chigubo	Reduction of water flow in river tributaries, deficit rainfall, uncontrolled burn, trees cut for charcoal production and firewood
Inhambane	Massinga, Funhaloro, Inhassoro, Govuro and Mabote	Reduction of water flow in river tributaries, deficit rainfall, uncontrolled burn, trees cut for charcoal production and firewood
Sofala	Nhamatanda, Gorongoza, Maringue, Chemba, Chibabava, Machanga and Buzi	Deficit rainfall, uncontrolled burn, deforestation, and erosion
Tete	Moatize, Magoe and Chgangara	Reduction of water flow in river tributaries, uncontrolled burn and deforestation
Manica	Macossa, Tambara and Machaze	Uncontrolled burn, excessive soil use and deforestation
Nampula	Nacaroa and Memba	Reduction of water flow in river tributaries, deficit rainfall, decontrolled burnt, trees cut for charcoal production and firewood

(MICOA – Relatório sobre o Estado do Ambiente – Moçambique – 2001)

Although livestock and pasture conditions are good in many areas of Mozambique, water borne diseases are causing higher than average mortality rates, especially in the southern and central regions where most livestock are located[10] (FEWS 2000). Further, due to budgetary limitations, along with public-sector domination of the delivery of veterinary services, livestock services for small-holders are low (International Fund for Agricultural Development 2000). Moreover, the most recent floods caused the death of 20,000 cattle and unknown numbers of chickens and other birds, resulting in reduced incomes and poorer diets to households raising livestock (Famine Early Warning System Network 2000).

Provinces most affected by stressed food and fibre provision services

- Cabo Delgado: Soil degradation; vulnerable to livestock loss
- Gaza: Deficit in cereal production; affected by drought with tendency to desertification
- Inhambane: Deficit in cereal production; affected by drought with tendency to desertification; vulnerable to livestock loss
- Manica: Steep slopes; soil degradation; affected by drought with tendency to desertification

10 Tsetse fly is found in Niassa, Cabo Delgado, Sofala, Nampula and Zambezia provinces, limiting the numbers of livestock found there.

- Maputo: Deficit in cereal production; desertification; vulnerable to livestock loss
- Nampula: Soil degradation; affected by drought with tendency to desertification
- Niassa: Soil degradation and encroaching desertification; vulnerable to livestock loss
- Sofala: Soil degradation; affected by drought with tendency to desertification; vulnerable to livestock loss
- Tete: Low soil suitability and steep slopes; affected by drought with tendency to desertification; vulnerable to livestock loss
- Zambezia: Soil degradation

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).

Mozambique's main water source is its rivers, particularly the Zambezi River which contributes 66 per cent of the surface water entering the country (FAO Land and Water Development Division 2005). The country has an internal renewable water resources (IRWR) rate of 99 cu km a year or 5,214 cu m per capita. Tanzania by comparison has an internal renewable water resource value of 82 cu km per year and a per capita level of 2,227 cu m (World Resources Institute. 2003f). The total natural renewable water resources (this includes inflows from other countries) for Mozambique is 216 cu km or 11,382 cu m per person. (World Resources Institute 2003g). Tanzania by comparison has 91 cu km of total renewable water resources or 2,472 cu m per capita.

Most of the country's population (49 per cent) obtains drinking water from wells, 29 per cent from surface water, 20 per cent from pipes, and one per cent from rain (Matimula 2003). In urban areas, the main source of water is surface water, but groundwater is heavily used for drinking water (FAO Land and Water Development Division, 2005). The consumption of piped water is a privilege for families mainly in urban areas, where 71 per cent receive this service, compared to nine per cent in rural areas where communities use pump-mounted borehole and shallow wells for drinking water (Matimula 2003; FAO Land and Water Development Division 2005).

State of freshwater supply, purification and regulation service

Total water withdrawals are roughly 0.6 cu km, or 42 cu m per capita, a withdrawal rate that is only 0.4 per cent of actual renewable water resources (World Resources Institute 2003g). Tanzania by comparison has a withdrawal rate of 39 cu m per capita, a withdrawal rate of only 1.6 per cent of the actual total renewable resources. The low withdrawal rate suggests that currently there is little pressure on Mozambique's water system in meeting demands, but many factors determine the country's renewable water resources and these need to be investigated in more detail. We know that the United Nations' minimum standard is 1,000 cu m of water per person annually; hence for the ecosystem to meet population demands, Mozambique requires an internal renewable water resource of approximately 19 cu km annually (Biggs *et al.* 2004). Although natural renewable water resources are adequate, and Mozambique's water resources are abundant relative to its population, any loss in internal recharge rates could lead to a shortage of groundwater. Mozambique is expected to hit water stress in the next 25 years (Mendes *et al.* 1998; Hall and Banda 2003). It is worth exploring the conditions under which this scenario is expected to occur because the internal IRWR of 99 cu km would ideally seem to be sufficient to meet growing demands. However, it should be acknowledged that the population is growing at an annual rate of 2.4 per cent.

Pollution of surface and coastal waters is an emerging problem (United States Central Intelligence Agency 2004). In suburban and rural areas, the coverage of safe water and environmental sanitation are low, and

in conjunction with other factors, result in areas with higher risk of contracting diseases linked to the environment (Matimula 2003).

Factors influencing water supply, purification and regulation

Despite the fact that industrialization and production levels in Mozambique are relatively low, urban areas, industry and agro-industries are sources of pollution having a large impact on their surrounding populations (Mendes *et al*. 1998). While most industrial activities are located in heavily populated areas where proper environmental impact assessments have not been done, there are numerous examples of polluting activities to draw from. Examples include: waste products, such as caustic soda and cellulose, from the textile and paper industries are dumped in rivers and streams in Manica; the petroleum refining industries situated in the major cities discharge untreated effluents into nearby bays; industrial chemicals, explosives, fertilizers, pesticides, persistent organic pollutants and paints from the chemical industry located in Maputo also pollute water; another problem is lead used in the old printing industry, gasoline and paints produced in Matola, just east of Maputo; arsenic and dioxins from tire and plastics combustion; and so on (Mendes *et al*. 1998; Matimula 2003).

Another source of water pollution is the mining industry (Mendes 1998). This occurs as mining excavations cause the movement of great amounts of land and water levels changes (National Biodiversity Unit of Mozambique 1994). Mines considered most responsible are the coal mines at Moatize (Tete), the copper mines at Mundonga (Sofala), the gold mines in Manica and the treatment of bentonite at Boane (Maputo) (National Biodiversity Unit of Mozambique 1994).

Domestic water contamination in rural, urban and peri-urban areas is also rife. Adequate treatment of human wastes using a drainage pipe and septic tank occurs in only two per cent of families in Mozambique; of these, 11 per cent are in urban centres and less than one per cent are in rural areas (Matimula 2003). About 65 per cent of families do not have access to any type of sanitary facility (Matimula 2003). Groups such as the Ndawus and Senas in Beira and some central to northern coastal populations do not use toilets, i.e., they defecate in open spaces, a practice that contributes significantly to water contamination and water-borne diseases, particularly diarrhea and cholera (Matimula 2003).

Statistics show that 33.3 per cent of families use a latrine. Of these, 26 per cent are in rural areas and 53 per cent are in urban areas (Matimula 2003). In peri-urban areas, infrastructure for human waste elimination is low; sanitation is threatened by contamination from flies, rodents and domestic animals (Matimula 2003). In urban areas, poor drainage results from an obsolete liquid waste drainage network such that wastewater frequently accumulates underground and flows across the streets.

Wetlands provide water purification and regulation, but are threatend from expanding agriculture, population growth and subsequent distress migration (Mendes *et al*. 1998). For example, in the upper catchments of the Sand River in Mpumalanga, South Africa, 80 per cent of wetlands and most of the grasslands have been tilled for farming or overgrazed (World Rainforest Movement 2002). This has removed the ground infiltration of rain runoff, which maximizes groundwater seepage into areas during dry periods, and reduced the surface runoff flowing into rivers and streams during high rainfall (Mendes *et al*. 1998).

The severity of recent floods is another indicator that water regulating ecosystem services are stressed. For example, in February 2000, widespread floods affected Mozambique, exacerbating lack of access to adequate sanitation and drinking water, and leaving nearly 800,000 people at risk of infectious diseases (World Health Organization 2005). These floods affected 1,500,000 people, a number three times higher than the average number of people affected by floods in Mozambique in the past three decades (United Nations Environment Network 2005). One of the main factors causing deterioration in flood regulation is deforestation and the removal of vegetative cover. Another factor is the conversion of wetlands to agriculture which has increased coastal erosion in Zambezia Province nearly destroyed the townships of Chinde and Macuse (Mendes *et al*. 1998). These effects are further compounded by the removal of mangroves along the coast which have in past been effective barriers against coastal storms and flooding.

As previously noted in the section on food provision, many provinces are experiencing periodic droughts. One of the main factors contributing to drought in reduction of flows in river tributaries, of which most originate in other countries where large amounts of water are being removed from rivers before they reach Mozambique.

Provinces most affected by stressed water supply, purification and regulation services

- Cabo Delgado: Erratic rainfall and prone to drought
- Gaza: Water supply is stressed; vulnerable to floods; water pollution from mining
- Inhambane: Water supply is stressed
- Manica: High levels of industrial pollution; vulnerable to floods; water pollution from mining
- Maputo: Water supply is stressed; high levels of industrial pollution; water pollution from mining
- Nampula: Vulnerable to floods
- Sofala: Vulnerable to floods; water pollution from mining erratic rainfall and prone to drought; wetland loss
- Tete: Vulnerable to floods; water pollution from mining; erratic rainfall and prone to drought
- Zambezia: Low water coverage; wetland loss

(http://www.lboro.ac.uk/well/resources/consultancy-reports/task0247.htm)

2.4 Fuel provision

Biomass fuels such as woodfuel, vegetal coal and animal dung are the main source of energy in Mozambique where only six per cent of the country's population is linked to the main energy grids and over half of these people live in the capital city of Maputo (Cuamba 1999; Global Environment Facility 2003). Of total energy consumption, 73 per cent is residential, 23 per cent industrial, and four per cent for transportation; woodfuel accounts for about 83 per cent of this, amounting to 6,468,000 metric tons of oil equivalents (toe) being consumed annually (Cuamba 1999; World Resources Institute 2003e). On the supply side, Mozambique produces 16,724,000 cu m of woodfuel and 600,000 of charcoal annually (World Energy Council and FAO 1999). Mangroves also provide important cheap woodfuel for dense coastal communities (Ghazvinian 2004, Duarte-Mangue and Oreste 1999).

In addition to wood, dung and crop residue are also used by households as an energy source. However, the supply of these biological products in turn depends on the amount of livestock available and the availability of crop residue after harvests. Livestock, though, are not numerous in Mozambique; as previously noted, livestock numbers declined dramatically during the 16 years of civil war and since then livestock disease and lack of veterinary services hamper production (Alders, Fringe and Mata 1997 *et al.*).

State of fuel as ecosystem service

Overall, energy production has been on the decline since the 1970s and total energy production in 2000 was 7,291,000 toe, down three per cent since 1980 (World Resources Institute 2003e). The reasons for this decline are not readily apparent from deforestation data, as Mozambique started fuel wood plantations[11] to meet their energy needs in 1978 and even though natural forest area declined two per cent between 1990 and 2000 plantations have increased by two per cent during the same period (World Resources Institute, 2003f)

Forests covers 38 per cent of Mozambique (30,601,000 ha), of which 30,551,000 ha are natural forests and approximately 50,000 ha are plantations (World Resources Institute 2003e, 2003f). Although a large quantity of wood remains in the country to provide energy, between an estimated 45,000 ha and 120,000 ha of forest disappear annually (Ghazvinian 2004, Mendes *et al.* 1998). Mangroves, a source of woodfuel for some of the most densely inhabited areas of Mozambique, are being deforested at a rate of over six sq km every year and from 1990–2000, total mangrove cover area was reduced from 396,600 ha to 390,500 ha (Ghazvinian 2004).

Factors influencing drop in biological fuel sources

Forests are being cleared for agriculture and the fuel needs of the high concentration of people in some areas due to internal migration and displacement (Mendes *et al.* 1998). Farmers practise slash and burn agriculture whereby a plot of land is cleared for cultivation and then abandoned when it loses fertility after several planting seasons (Ghazvinian 2004). If plots are given sufficient time to recover and become fertile, this practice is sustainable in small populations.

11 In addition, the preferred species in forest plantations, the eucalyptus, may be ecologically problematic, as it consumes large amounts of water and nutrients (AD).

However, population growth creates more pressures for land and greater areas are being deforested to provide enough land for crop cultivation, with less fallow time allowed (Ghazvinian 2004). As well, population growth in urban areas and along main road corridors leads to a dramatic increase not only in the requirement for agricultural land, but for forest, fuel and wildlife products. Fire is often employed to clear land for hunting, timber harvest and the acquisition of other forest products, including charcoal, honey and for protection against wild animals, often leading to uncontrollable wildfires (FAO Forestry Department 2000). Approximately 40 per cent of the country is affected by forest fire every year (FAO Forestry Department 2000).

Forest fuel resources are also lost to logging and profit-driven timber exportation (Ghazvinian 2004). The timber industry earns an enormous profit on exportation—from 1997 to 2001, the country exported over US$85 million worth in timber (Ghazvinian 2004). Its exports to China, which receives about 80 per cent of its exports, alone ran at almost $70 million (Ghazvinian 2004).

Provinces most affected by stressed fuel provision services

Deforestation and woodland clearing, which can be considered a proxy indicator for the availability of woodfuel ecosystem services, is occurring in the following provinces: Cabo Delgado, Gaza, Inhambane, Manica, Maputo, Nampula, Niassa, Sofala, Tete and Zambezia.

2.5 Summary of ecosystem services stressed

The disruptions caused by years of civil unrest are still being felt in Mozambique. During the civil war, huge numbers of people were displaced and many migrated to coastal areas or to other surrounding countries and millions returned in the mid-1990s. In this situation, immediate survival was primary, hence up-to-date information on ecosystem services was difficult to find and many data gaps exist.

Despite the many data gaps, this overview illustrates the immediate and close links of the people of Mozambique to their environment and the many services provided by it. Among these are biologically diverse forest ecosystems that provide food, shelter, fuel and medicines, prevent widespread erosion and help regulate water supply and quality. In addition, being a source of drinking water, watersheds and wetlands help mitigate against floods and droughts, thus contributing to the viability of crop lands and food provision.

This brief overview of just four ecosystem services shows, however, that ecosystem services are stressed in all provinces, with the sole exception being water supply, quality and regulation in Niassa Province. Biodiversity loss is notable, as species are threatened by poaching and eating of bush meat, yet in some areas habitat remained intact due to out-migration by the population during the civil war. Many of these areas are being re-inhabited, however, and increasing population density could exacerbate already fragile ecosystem services.

Immediate areas of concern include rapid rates of deforestation, which are connected to several problems including loss of biodiversity, coastal erosion and droughts and flooding, and increasing levels of water pollution, which contributes to human illness as well as environmental loss and water abstraction, which contributes to drought in many provinces.

Table 2. Summary: Ecosystem services stressed by region

Region	Ecosystem services stressed
Cabo Delgado	Biodiversity Food provision Water supply, purification and regulation Fuel
Gaza	Biodiversity Food provision Water supply, purification and regulation Fuel Flood regulation
Inhambane	Biodiversity Food provision Water supply, purification and regulation Fuel
Manica	Biodiversity Food provision Water supply, purification and regulation Fuel Flood regulation
Maputo	Biodiversity Food provision Water supply, purification and regulation Fuel
Nampula	Biodiversity Food provision Water supply, purification and regulation Fuel Flood regulation
Niassa	Biodiversity Food provision Fuel
Sofala	Biodiversity Food provision Water supply, purification and regulation Fuel Flood regulation
Tete	Biodiversity Food provision Water supply, purification and regulation Fuel Flood regulation
Zambezia	Biodiversity Food provision Water supply, purification and regulation Fuel

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 reported in this report. Our preliminary review identified the following critical constituents which appear to be under serious threat among many social groups within Mozambique.

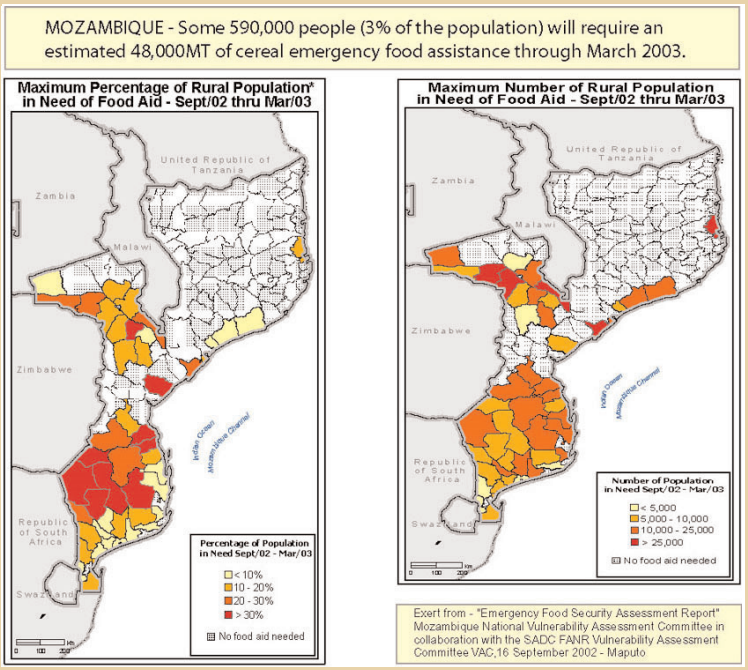
3.1 Ability to be nourished

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 an income from non-farm labour, are also important (Sen 1990). There are several measures of the ability to be adequately nourished including that of food (in)security and the incidence of malnutrition, among others

State of ability to be adequately nourished

Nearly 80 per cent of the Mozambican population relies on agriculture as a main source of food for subsistence (Mendes *et al.* 1998). As subsistence crop production dominates the agricultural economy, the main factor determining poor nourishment is the inability to grow food. While food supply is characterized by impressive gains toward restored food security since the end of civil war at a national level, uneven spatial distribution of food supply, of natural disasters and land desertification cause local food insecurity.

Map 2. Food security: Maximum percentage and numbers of rural population in need of food aid – September 2002 through March 2003



(Mozambique Vulnerability Assessment Committee and SADC FANR Vulnerablity Assessment Committee 2002)

In 2001, 53 per cent of the population in Mozambique was undernourished, down from 69 per cent in 1992 (Forum for Food Security 2004, 7). However, the average calorie supply from animal products is also the lowest it has been since the 1960s, at 44 kilocalories (United Nations Environment Network 2005). Furthermore, based on 1997 data, 26 per cent of children under the age of three years are underweight and 38 per cent stunted, i.e., low height to age ratio (Forum for Food Security 2004, 8).

Table 3. Percentage of children with chronic malnutrition and/or underweight/province

Province	Rank (chronic malnutrition)	Chronic malnutrition children 0–5 years	Underweight children 0–5 years
Cabo Delgado	1	56%	34.2%
Gaza	7	34%	22.6%
Inhambane	8	33%	12.8%
Manica	6	39%	22.9%
Maputo	9	24%	9.2%
Nampula	5	42%	28.2%
Niassa	2	47%	25.1%
Sofala	4	42%	26.2%
Tete	3	46%	25.1%
Zambezia	2	47%	26.9%

(After UNICEF 2004)

The ability to be nourished depends not only on food supply, but also on the economic entitlements to buy food. In 2001, maize prices declined in the country's major markets and were lower than the year before (FAO GIEWS 2001). The retail price of white maize grain decreased within the range from 0.4 per cent in Maputo to 33.8 per cent in Lichinga (Famine Early Warning System Network 2000). However, the retail price of white maize grain was 50 per cent higher compared to two years earlier, in the southern region, where there was a deficit, than the northern region where there was a surplus. The deterioration of the national road linking the southern and northern provinces has lead to this price difference (Famine Early Warning System Network 2000).

Provinces most affected by in ability to be adequately nourished

Food insecurity is mainly affecting the south and central regions where the number of vulnerable people in need of food assistance in the year 2002 was 590,000 or three per cent of the total population (Mozambique. Vulnerability Assessment Committee and SADC FANR Vulnerablity Assessment Committee 2002). For 2003, the provinces most affected are:

- Gaza: Food insecure population in 2003; 34 per cent chronic malnutrition children 0–5 years
- Inhambane: Food insecure population in 2003; 33 per cent chronic malnutrition children 0–5 years
- Manica: Food insecure population in 2003; 39 per cent chronic malnutrition children 0–5 years
- Maputo: Food insecure population in 2003; 24 per cent chronic malnutrition children 0–5 years
- Nampula: One district with food insecure population in 2003; 42 per cent chronic malnutrition children 0–5 years
- Sofala: Food insecure population in 2003; 42 per cent chronic malnutrition children 0–5 years
- Tete: Food insecure population in 2003; 46 per cent chronic malnutrition children 0–5 years
- Zambezia: Two districts in Zambezia food insecure population in 2003; 47 per cent chronic malnutrition children 0–5 years

Interestingly, the two provinces with the highest chronic malnutrition in children 0–5, Cabo Delgado, which ranked first at 56 per cent and Niassa, which ranked second at 47 per cent are not among the provinces showing population in need of food assistance in 2003.

3.2 Ability to access adequate clean water

Access to adequate and clean drinking water is essential for life. As indicated in the freshwater provision section, 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). In addition, clean water is a necessary condition for a healthy life and to be protected against water-borne diseases like typhoid and cholera. Clean water can be provided in a number of ways such as filtration plants using modern technology, but it is also well known that a watershed 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 access adequate clean water

Table 4. Percentage of people with access to safe drinking water/province (2003)

Province	Ranking 1= lowest % with access 9 = highest % with access	Percentage of people with access to safe drinking water
Cabo Delgado	5	41.6%
Gaza	9	50.2%
Inhambane	3	31.6%
Manica	6	47.1%
Maputo	8	48.9%
Nampula	4	32.2%
Niassa	2	30.2%
Sofala	7	47.7%
Tete	5	41.6%
Zambezia	1	13.7%
National		35.7%

(After UNICEF 2004)

Nationally, only 35.7 per cent of the population has access to safe water (UNICEF 2004). The average distance to carry water is 1-1/2 miles and many communities have broken or contaminated water sources that have been in a state of disrepair for years (World Vision 2003; World Hope International 2004). Moreover, water is often consumed with high fecal contamination, a leading cause for the high incidences of diarrhoeal diseases (Matimula 2003). Cholera is also a problem; Nampula Province was badly hit by this disease following the 2001 flooding and Maputo and Gaza also suffer high rates of cholera, reporting 1,840 cases in one month in 2003 (World Vision 2003; UNICEF 2003).

Provinces most affected by inability to access adequate clean water

Inhambane is one of Mozambique's driest provinces and some women spend up to five hours a day trekking 24 km to fetch 20 litres of water (World Health Organization 2001a). In Mutarara district in rural Tete Province, they must walk three to five km to access water (World Vision 2003). In Nalaze community in Maputo, people must wait in very long lines to get their water (World Hope International 2004).

All provinces face water problems; more than 50 per cent of their population are without access to water (see Table 4). This coincides with the information found on water supply, quality and regulation in the ecosystem services section except for Niassa Province. Based on the information available, this was the only province that did not seem to have this ecosystem service stressed, possibly because it borders Lake Niassa and is thought to have adequate water supply; yet, according to the data in Table 4, only 30.2 per cent of its population has access to safe drinking water.

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. Traditional fuel consumption of mainly woodfuel accounts for 90.5 per cent of total energy requirements; in rural areas woodfuel is obtained from indigenous forests while in urban areas are more frequently gathered from wood industries as residues (Duarte-Mangue 2000; United Nations Development Programme 2004).

People burn 17,037,282 cu m of wood each year or 1.06 cu m of wood per capita/year, to satisfy their energy needs (World Energy Council and FAO 1999). In rural areas, woodfuels account for almost 100 per cent of energy consumed, but since population density in rural areas is relatively small, wood from dead trees or those felled to clear forested areas for agriculture can meet the energy demands in most

regions (Duarte-Mangue 2000; Ghazvinian 2004). As few energy alternatives are available, the majority of urban households are also dependent on charcoal and woodfuel (Duarte-Mangue 2000). In coastal regions, however, where the population density is much greater, the need for wood as a cheap energy source is greater, and Mozambicans cut trees to satisfy fuel requirements (Ghazvinian 2004). Through the 1990s, per capita energy consumption decreased by 19 per cent (World Resources Institute 2003e)

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

Due to a lack of data on fuel wood consumption, deforestation rates provide a proxy indicator. These data, however, are not current and should be interpreted with caution. According to data collected by Saket (1994), (Duart-Mangue 2000), the amount of natural forest increased from 19,129,480 ha in 1980 to 19,735,400 ha in 1990; thicket increased from 19,880,998 ha in 1980 to 26,278,471 ha in 1990, but mangroves declined from 455,500 ha in 1980 to 396,080 ha in 1990. These data are consistent with the analysis done for the World Wildlife Fund terrestrial ecosystem assessment and described in more detail in the ecosystem services section on biodiversity whereby inhabitants vacated several rural forested areas during the civil war, leaving habitat intact and in some cases it regenerated. A large number of people, however, migrated to urban areas and along the coast, thus putting increased pressures on mangrove forests. This situation is changing, though, as people return to formerly settled areas.

Based on the biodiversity data and using deforestation as a proxy indicator, people in the following provinces are probably finding it more difficult to obtain fuel wood:

- Cabo Delgado: Eastern miombo woodlands threatened by deforestation
- Gaza: Southern Zanzibar-Inhambane coastal forest mosaic threatened by forest clearing for agriculture and commercial logging
- Inhambane: Southern Zanzibar-Inhambane coastal forest mosaic threatened by forest clearing for agriculture and commercial logging
- Manica: Eastern Zimbabwe montane forest-grassland mosaic threatened by clearing for agriculture and contains landmines
- Maputo: Deterioration of mangroves; Southern Zanzibar-Inhambane coastal forest mosaic threatened by forest clearing for agriculture and commercial logging
- Nampula: Eastern miombo woodlands threatened by deforestation; Southern Zanzibar-Inhambane coastal forest mosaic threatened by forest clearing for agriculture and commercial logging
- Niassa: Eastern miombo woodlands threatened by deforestation
- Sofala: Deterioration of mangroves; Zambezian coastal flooded savannah threatened by dam construction, poaching, human settlements, agriculture development and population growth; Southern Zanzibar-Inhambane coastal forest mosaic threatened by forest clearing for agriculture and commercial logging
- Tete: Eastern Zimbabwe montane forest-grassland mosaic threatened by clearing for agriculture and contains landmines
- Zambezia: Eastern miombo woodlands threatened by deforestation. Southern Zanzibar-Inhambane coastal forest mosaic threatened by forest clearing for agriculture and commercial logging

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 or thresholds are typically established using an estimate of the cost of food and non-food basic needs for individuals and families.

State of ability to earn a livelihood

Mozambique's economic entitlements are low: 69.4 per cent of the population lives below the poverty line (Mozambique 2001). Subsistence agriculture employs the vast majority of the country's workforce, though there are several cash crops grown by many small landowners. Among these are sugarcane, cashews and cotton with small planters holding approximately 40 per cent of the land growing these crops (Bethelemy, Kauffmann and Wegner 2004). In

2003, agricultural activity increased by 4.3 per cent primarily due to more sugarcane production, a lucrative cash crop to which many farmers had switched after prices for other commodities such as cashew and cotton fell (Bethelemy, Kauffmann and Wegner 2004). International dynamics are also impacting the fishery sector. About 80 per cent of total fish catch is by artisanal fishers, but markets for the high-valued prawns fishery in Mozambique is controlled by Japanese and Spanish companies involved in the country's fisheries. Good prices, though, can be obtained from the South African market (South African Development Community, Marine Fisheries and Resources Sector 2000).

Natural disasters such as droughts and floods interrupt farm production, transportation and the ability to earn a livelihood generally. Unfortunately, the level of poverty in the country substantially reduces resilience and coping strategies in the face of these disasters at both the individual and government levels and the effects are cumulative, as asset depletion increases (Forum for Food Security 2003, 15).

Provinces most affected by inability to earn a livelihood

Table 5. Poverty level by province

Province	Percentage of people in poverty
Cabo Delgado	57.40%
Gaza	64.66%
Inhambane	82.60%
Manica	62.60%
Maputo	65.60%
Nampula	68.92%
Niassa	70.64%
Sofala	87.92%
Tete	82.27%
Zambezia	68.10%

(Woldemariam, Elizabeth and Mohammed 2003)

Monetary poverty is mainly a rural phenomenon, affecting around 71 per cent of the rural population, compared to 62 per cent of the urban population (Mozambique 2001).The provinces with the highest poverty headcount index are Sofala (87.9 per cent), Inhambane (82.6 per cent), Tete (82.27 per cent) and Niassa (70.64 per cent), though the incidence of poverty is over 50 per cent in all provinces.

3.5 The ability to be secure against extreme events like droughts and floods

One of the striking features of Mozambique is the high degree of vulnerability the people face from the hazards of droughts and floods. It would seem paradoxical at first that you can have both at the same time. However, as our previous analysis highlights, it can happen particularly when some of the ecosystem services become deteriorated. The water supply in Mozambique is not a problem as it has a very high internal renewable water resources per capita level. The problem lies in water regulating services and the solution in managing water systems so that the ability of the ecosystems to catch rainfall and store it is improved. Presently, forests are being destroyed and the landscape altered to the extent that catchments are disappearing.

Floods seem to be a frequent event in Mozambique with disastrous consequences, particularly on the portion of the population that is highly dependent on subsistence agriculture. Not only are crops damaged thereby causing many to lose the ability to get adequate nourishment, but destruction of material assets like houses cause financial hardship to a population which has very little insurance against events like these. A repetitive cycle of floods and droughts can only cause a downward spiral of impoverishment.

Provinces most affected by inability to be secure against extreme events like drought and floods

The provinces most affected by floods are similar to the provinces which have witnessed a loss in the flood regulation ecosystem service as well as those provinces which have seen a high rate of deforestation. The main provinces experiencing floods are Gaza, Manica, Nampula, Sofala and Tete, while those facing droughts are Gaza, Maputo and Inhambane, which are primarily located in the south.

3.6 Summary of constituents of well-being under threat

The plight of the people of Mozambique is readily apparent. Their constituents of well-being are under threat in all provinces; though the severity of threat varies, it is sufficient in each case to warrant attention. The ongoing challenges in rebuilding after the long civil war, resettlement of millions of people and, in the face of recurring natural disasters, are enormous. In addition, the provinces of Gaza, Inhambane, Manica, Maputo, Sofala and Tete are vulnerable to floods and droughts.

Some of the results in the table below need to be read with caution, as adequate data were not available for some of the provinces. This is particularly true of the ability to have adequate energy where deforestation was used as a proxy indicator and hence all provinces were listed, even though recent research on fuel wood consumption shows that energy needs can be met by harvesting dead wood and trees felled for agriculture. Another discrepancy in the data appeared in the ability to be adequately nourished. Even though Cabo Delgado and Niassa did not have food security problems, they had the most children experiencing chronic malnutrition and based on this information were included.

Table 6. Constituents of well-being under threat/province

Provinces	Constituents threatened
Cabo Delgado	Adequately nourished Adequate and clean drinking water Energy Earn a livelihood
Gaza	Adequately nourished Adequate and clean drinking water Energy Earn a livelihood Vulnerability to floods and droughts
Inhambane	Adequately nourished Adequate and clean drinking water Energy Earn a livelihood Vulnearbility to droughts
Manica	Adequately nourished Adequate and clean drinking water Energy Earn a livelihood Vulnerability to floods
Maputo	Adequately nourished Adequate and clean drinking water Energy Earn a livelihood Vulnerability to droughts
Nampula	Adequately nourished Adequate and clean drinking water Energy Earn a livelihood Vulnerability to floods
Niassa	Adequately nourished Adequate and clean drinking water Energy Earn a livelihood
Sofala	Adequately nourished Adequate and clean drinking water Energy Earn a livelihood Vulnerability to floods
Tete	Adequately nourished Adequate and clean drinking water Energy Earn a livelihood Vulnerability to floods
Zambezia	Adequately nourished Adequate and clean drinking water Energy Earn a livelihood

4.
Linking Ecosystem Services to Human Well-being

While most ecosystem services are stressed and most human well-being constituents are threatened in all provinces, Gaza, Manica, Nampula, Sofala and Tete stand out from the rest, as all five ecosystem services and constituents are stressed and threatened. These five provinces are followed closely by Inhambane and Maputa provinces, where four ecosystems are stressed and five constituents are threatened. This leaves Cabo Delgado, Niassa and Zambezia, but even in these provinces several ecosystem services and constituents are listed. The comprehensive nature of the results of this overview clarify the profound needs of the people in this country and how better management of ecosystem services could aid them. Not to be dismissed, though is the confounding factor of recurrent natural disasters, which are wreaking havoc as the country rebuilds after years of war.

It can be argued that provinces with the highest population density should be a priority and in the case of Mozambique this would be the two provinces of Nampula and Zambezia which have 39 per cent of the total population. This choice is supported by the data. In Nampula, for example, 42 per cent of the children 0–5 years suffer from chronic malnutrition and 32.2 per cent of the population has access to clean water, while in Zambezia the numbers are worse: 47 per cent of children 0–5 years suffer from chronic malnutrition and only 13.7 per cent of the population has access to clean water.

Table 7. Ecosystem services stressed and human well-being by province

Provinces	Ecosystem services stressed	Constituents stressed
Cabo Delgado	Biodiversity Food production Water supply, purification and regulation Fuel	Adequately nourished Adequate and clean drinking water Energy Earn a livelihood
Gaza	Biodiversity Food production Water supply, purification and regulation Fuel Flood regulation	Adequately nourished Adequate and clean drinking water Energy Earn a livelihood Vulnerability to floods and droughts
Inhambane	Biodiversity Food production Water supply, purification and regulation Fuel	Adequately nourished Adequate and clean drinking water Energy Earn a livelihood Vulnerability to drought
Manica	Biodiversity Food production Water supply, purification and regulation Fuel Flood regulation	Adequately nourished Adequate and clean drinking water Energy Earn a livelihood Vulnerability to floods
Maputo	Biodiversity Food production Water supply, purification and regulation Fuel	Adequately nourished Adequate and clean drinking water Energy Earn a livelihood Vulnerability to drought

Provinces	Ecosystem services stressed	Constituents stressed
Nampula	Biodiversity Food production Water supply, purification and regulation Fuel Flood regulation	Adequately nourished Adequate and clean drinking water Energy Earn a livelihood Vulnerability to floods
Niassa	Biodiversity Food production Fuel	Adequately nourished Adequate and clean drinking water Energy Earn a livelihood
Sofala	Biodiversity Food production Water supply, purification and regulation Fuel Flood regulation	Adequately nourished Adequate and clean drinking water Energy Earn a livelihood Vulnerability to floods
Tete	Biodiversity Food production Water supply, purification and regulation Fuel Floods regulation	Adequately nourished Adequate and clean drinking water Energy Earn a livelihood Vulnerability to floods
Zambezia	Biodiversity Food production Water supply, purification and regulation Fuel	Adequately nourished Adequate and clean drinking water Energy Earn a livelihood

Nampula also suffers from floods and it would be useful for policymakers to get more detailed information on the specific links between the various ecosystem services and the constituents of well-being across the communities living in the province.

In general, Mozambique has a high potential for improving the well-being of its populations by proper management of the five ecosystem services identified in this report. Many of the ecosystem services are inter-dependent. For example, there is a high probability that deforestation has increased the frequency of floods and droughts. Similarly, unsustainable clearing of land for agriculture to increase food production has contributed to drops in soil fertility and water systems disruption leading eventually to crop yield declines. A multi-scale integrated assessment will provide answers to these trade-offs and the suite of responses which will be needed to ensure poverty reduction strategies to be effective and for Mozambique to achieve its Millennium Development Goals.

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